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OF THE  
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VOL. IV.

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December 1888.

THE  
*A N A T O M Y*  
OF THE  
H U M A N B O D Y.

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V O L. IV.

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CONTAINING THE  
*ANATOMY OF THE VISCERA OF THE ABDOMEN,*  
*THE PARTS IN THE MALE AND FEMALE PELVIS,*  
*AND THE LYMPHATIC SYSTEM.*

PART I.  
OF THE ABDOMINAL VISCERA.  
INTRODUCTORY VIEW OF THE SYSTEM OF THE VISCERA, AND  
OF THE STRUCTURE OF GLANDS.

CHAP. I. OF THE STOMACH AND INTESTINES.  
CHAP. II. OF THE LIVER, SPLEEN, PANCREAS, AND KIDNEY.

PART II.  
OF THE MALE PARTS OF GENERATION.  
CHAP. I. OF THE PARTS WITHIN THE PELVIS.  
CHAP. II. OF THE PARTS CONNECTED WITH THE VISCERA OF  
THE PELVIS, BUT SITUATED WITHOUT IT.

PART III.  
OF THE PARTS OF THE FEMALE PELVIS.

PART IV.  
OF THE LYMPHATIC SYSTEM.

---

WITH AN APPENDIX.

---

*By* CHARLES BELL,  
FELLOW OF THE ROYAL COLLEGE OF SURGEONS OF EDINBURGH.

---

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AND T. CADELL AND W. DAVIES, STRAND.

1804.





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EXPLANATION  
OF THE  
P L A T E S.

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PLATE I

**T**HIS plate represents an ideal section of the abdomen, and the cut edge of the peritoneum is represented by the white line.

- A. The LIVER.
- B. The INTESTINES.
- C. The KIDNEY.
- D. The BLADDER OF URINE.
- E. The RECTUM.
- 1. The PERITONEUM, where it lines the abdominal muscles.
- 2. The PERITONEUM, where it is reflected to form the ligament of the liver.
- 3. The liver being represented cut through, we can trace the lamina of the ligament 2, over its surface

surface 3, forming the peritoneal coat of this viscus.

4. Marks the PERITONEUM reflected from the liver upon the diaphragm.
5. Here the PERITONEUM is reflected off from the spine, to form one of the lamina of the mesentery.
6. The peritoneal coat of the intestine, which we can trace round the circle of the gut until it unites again with the mesentery.
7. 7. The PERITONEUM, forming the lower lamina of the mesentery.
8. The PERITONEUM at that part where it is reflected, and covers the kidney.
9. The PERITONEUM is here descending upon the rectum E, we see it reflected over the gut, and descending again betwixt the rectum and bladder.
10. The PERITONEUM where it forms a coat to the fundus of the bladder.
11. At this part we see the peritoneum reflected up upon the os pubis, and from that we trace it to fig. 1. Thus we see, that the peritoneum can be traced round all its various inflections and processes; which shews, that it forms one continuous sac, and that the intestines and the liver are equally on the outside of this membrane with the kidney.

## EXPLANATION OF PLATE II.

This Plate represents the epididimis and testicle, injected with quicksilver, and dissected.

- A. The body of the testicle with the tunica albuginea dissected off.
- B. B. The femoral vessels in the body of the testicle, OF TUBULI TESTIS \*.
- C. The RETE TESTIS formed by the the union of the vessels B. B.
- D. The VASA EFFERENTIA, which as they proceed from the testicle, are convoluted in a conical figure, and are called the VASCULAR CONES.
- E. E. The EPIDIDIMIS formed of the union of the vascular cones; it is a little dissected and spread out.
- F. The vas deferens.

## EXPLANATION OF PLATE III.

This Plate represents the prostate gland, vesiculæ feminales, and lower part of the bladder, the parts being previously hardened in spirits, the vesiculæ were afterwards cut open.

- A. A. The body of the PROSTATE GLAND; it is that lower part of the gland which can be felt through the rectum.
- B. The prostate gland is here cut into and dissected, in following the ducts of the vesiculæ.
- C. The extremities of the ducts common to the vesiculæ feminales and vasa deferentia.

\* Where the tubuli are emerging to form the rete vasculosum, or rete testis, they are called the *vasa recta*.

D D. The



**IV**                      **EXPLANATION OF THE PLATES.**

- D D.** The cells of the vesiculæ seminales, which are laid open by a section.
  - E** The left **VAS DEFERENS**, which is also laid open to shew the cellular structure which it assumes towards its termination
  - F.** The **RIGHT VAS DEFERENS**.
  - G G.** The foramina, by which the vasa deferentia open into the common duct.
  - H.** The lower and back part of the **BLADDER**.
  - I.** The **RIGHT URETER**.
- 

**EXPLANATION OF PLATE IV.**

This plate represents a section of the neck of the bladder.

- A.** The lower part of the urinary bladder near the neck.
- B.** The opening of the right ureter, which is marked **I. fig. iii.**
- C C.** The substance of the prostate gland, which is cut through; its thickness, texture, and the manner in which it surrounds the beginning of the urethra, will be understood from this plate.
- D.** The **URETHRA** laid open.
- F.** The **VERUMONTANUM**, or **CAPUT GALINAGINIS**.
- G G.** The points of feathers put into the openings of the vesiculæ seminales and vasa deferentia.

**N. B.** Round these ducts, on the surface of the verumontanum, and in that part of the urethra which is surrounded by the prostate gland, innumerable mucous ducts may be observed: into some of these small bristles are introduced.

---

EXPLANATION  
OF THE  
P L A T E S.

---

PLATE VI.

FIG. 1.

AN ovum in a very early stage, representing the shaggy surface of the true chorion.

FIG. 2.

We may see here the foetus in a very early stage contained in the transparent amnion, and, attached to the outside of the amnion, the VESICULA UMBILICALIS.

N.B. These are not representations of the same abortion.

Fig. 3.

Represents the ovum a little more advanced.

- A. The CHORION.
- B. The AMNION.
- C. The FOETUS hung by the UMBILICAL CHORD.

## EXPLANATION OF PLATE VII.

This plate represents two views of a conception, we shall say about the end of the first month, and here the decidua and the ovum have been thrown off together. This abortion was prepared so as to resemble the beautiful engravings in Dr. Hunter's xxxiv table.

FIG. 1.

The deciduous efflorescence formed by the womb is seen here intire, and seen as if moulded to the cavity of the womb: it is only necessary to observe that it hung inverted.

- A. The lower part of the conception, which was near the neck of the womb, and which has some coagula of blood attached to it.
- B. B. Quills introduced within the decidua by an opening near the neck of the womb, and their points brought out at that part of the membrane which answers to the opening of the Fallopean tubes: there it is either entirely deficient, or it is so thin that it has been torn at
- C. C.

FIG. 2.

Here the other side of the conception is shewn, and the ovum is seen to have adhered to the outer surface of the decidua.

- AA. AA. The quills introduced into the cavity of the decidua.
- B. The shaggy surface of the decidua.
- C. C. The fleecy outer surface of the chorion.

It

### EXPLANATION OF THE PLATES.

III

It is here to be observed that the ovum, C D E. may be supposed to be as it has descended from the ovarium, only somewhat enlarged, and it is here evidently on the outside of the decidua, but it has been torn open, and that deciduous surface which connected it to the surface of the womb at this place has been left with the womb, to be afterwards thrown off with the discharges.

- D. The delicate membrane the amnios.
  - E. The umbilical cord, and part of the foetus.
- 

### EXPLANATION OF PLATE VIII.

This and the following plate represents a conception of the third month, and as the abortion was thrown off very intire, we have another opportunity of observing the state of the decidua in a more advanced state.

- A. A thread passed through the more solid placental mass suspending the whole.
- B. B. The DECIDUA, having a peculiar reticulated appearance.
- C. C. Shreds of the DECIDUA, where it has burst in the delivery.
- D. The DECIDUA REFLEXA, through which also the proper membranes have burst.
- E. The TRUE CHORION.
- F. Very small curling arteries which are entering the decidua, or what may be considered as the maternal portion of the placenta.

EXPLA-

## EXPLANATION OF PLATE IX.

We have here presented a view of a section of the same conception.

- A. The DECIDUA.
- B. B. The cut edge of the DECIDUA, which will be seen to surround the whole ovum, and particularly it may be observed to form on the upper part a distinct lamina from the placenta F.
- C. C. The DECIDUA.
- D. The DECIDUA REFLEXA.
- F. The PLACENTA already formed by the accumulated vessels of the chorion.
- G. The CHORION towards the lower part of the womb; here, it may be observed the fleshy vessels have disappeared.
- H. The AMNION.
- I. The umbilical cord twisted three times around the neck of the fœtus.







- |  |                                       |
|--|---------------------------------------|
| A. Crux penis.                               | E. Venucle Semin.                     |
| B. Bulb of the Urethra.                      | F.F. Vasa deferentia.                 |
| C. Membranous p <sup>t</sup> of the Urethra. | G. The Uter.                          |
| D. Prostate Gland.                           | H. Bladder covered by the Peritoneum. |





Fig. 1.



Fig. 2.



Fig. 3.



Chas. Bell del.

D. Lillie sc.

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Fig. 1.



Fig. 2.







Drawn by Chas. Bell.

Engraved by D. Wilson.

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Chas. Bell del.

D. Liversidge sc.

Published by Longman & Rees. May 9<sup>th</sup> 1804.





PART THE FIRST.



*OF THE ABDOMINAL VISCERA.*

Vol. IV.

B



## INTRODUCTION.

---

### VIEW OF THE SYSTEM OF THE VISCERA, AND OF THE STRUCTURE OF GLANDS.

**I**N this last volume we have to comprehend the anatomy and functions of the several viscera of the abdomen and pelvis, considered not only as individual parts, but as connected together and as forming with the lymphatic and circulating systems of vessels a great part of that chain of mutual dependance and relation which constitutes the animal œconomy a whole. It becomes necessary therefore to take here a slight and cursory view of the œconomy of the intestinal canal and absorbing system, including at the same time something of the history of opinions regarding secretion and the structure of glands. It will be understood, that these introductory observations are meant only to combine the several parts, and to prevent that manner of description, which is necessary to accuracy and minuteness; from leading us to consider the several parts as distinct and insulated.

An animal body is never for a moment stationary: the remotest part is in action, and every point is suffering a perpetual change. From the first moment of our existence we have commenced a revolution: we, by slow degrees, advance in activity and strength, and ripen to maturity; but by as slow and as sure gradations we

decline to feebleness and infirmities : and the more rapidly that animals advance in the first stage of their progress, so is the proportion of their decline.

But it is not in observing the changes of the animal body from youth to age that the operations of the œconomy are the most interesting. It is when we find the living body to consist of parts performing a variety of functions, and these connected and mutually dependant ; when we see the circulating fluid throwing out fluid and solid secretions to build up and support the body, which is in incessant and daily decay. Again, our admiration is strongly excited when we observe the system to consist of fluids and solids, and the existence of the animal to depend upon the balance of their power ; the fluids separating and combining in new affinities, and forming the various secretions ; and the solids having action, and that action controlling the affinities and new combinations of the circulating fluids. We find that life subsists by the due action of solids and fluids ; or that an incomprehensible influence in a living body is exerted on the latter, and that the chemist can never so combine the fluids out of the body as to imitate the changes produced in a living system of fluids and vessels. Forgetting that animation is the essential character of living bodies, physiologists have too much endeavoured in every age to explain the phenomena of animated nature by illustrations drawn from mechanics, chemistry, or hydraulics.

In a body in which there is life there is a perpetual waste ; first by secretions, which for particular purposes are thrown into the cavities, and afterwards carried out of the body entirely by the excretions of the kidney,  
the

the perspiration by the surface, the exhalation by the lungs, the secretions of the internal cavities as of the intestines. But more than this, there is a decomposition of the solids of the body which are carried into the circulating fluids, and finally dismissed from the system. Lastly, we cannot but observe, that even the powers of muscular motion, nay, the powers of the mind and of the senses, are exhausted by exercise, and renovated through the influence of the circulation. The continued action of a muscle is followed by feebleness and the continued impression of the rays of light exhausts the retina, so that the object becomes first faint and then vanishes.

Since there is waste of the solids and fluids, and exhaustion of the energies of the system, so also must there be a source of supply, and means of renovating its action. Accordingly animals have appetites requiring the supply of food, and the call of hunger is controlled by the necessities of their system. When food is received into the first passages, there is thrown out from the stomach a fluid which dissolves it, changes its properties, and is itself essentially altered. The work of assimilation is thus begun. As this converted fluid takes its course through the intestines, it is more and more changed; more assimilated to the nature of the peculiar fluids of the animal; and having still additional secretions united to it, particularly the bile, it is by these means separated from the grosser parts of the aliment. This fluid, which is now called chyle, is absorbed by a particular and appropriate system of vessels, which, from their conveying this white and milky-like fluid, are called the lacteals. The lacteal

vessels carry the chyle to the thoracic duct, the trunk of the absorbing system; but not directly; for the chyle is deposited in the mesenteric glands, from which it is again absorbed and carried forward. Or if we suppose these glands to be merely convoluted vessels, its flow is at least delayed, so that it is not at once thrown into the mass of circulating fluids.

We find then that the stomach performs digestion, and the spleen, we will venture to affirm, is subservient to it. The secretion of the liver we find to prepare the chyle for absorption, while at the same time it is the peculiar stimulus to the intestines. The pancreas pours out a fluid which tempers the acrid bile. The superior part of the intestinal canal absorbs the nutritious fluid or chyle, while the gross remains of the food move on to be deposited in the great intestines. The great intestines are not only receptacles, but form at the same time an extensive secreting surface useful in the œconomy, by throwing off the waste of the system.

The lacteal vessels, which take up the chyle, are but branches of the system of absorbents—which is a system consisting of two great divisions, the lacteals and lymphatics: the first receiving the nutritious fluids from the intestinal canal, and the latter being absorbents, taking up the fluids which have been thrown out upon the cavities and surfaces of the body; and we presume upon the solid parts of the body also. Thus the new fluids, rich in supplies, are mingled with those which are fraught with the waste and decomposition of the system. The thoracic duct, the trunk of this system, conveys these fluids thus mingled together  
into

into the right side of the heart, where they are received into the vortex of the circulating red blood. These fluids, now agitated and wrought up with the blood in the cavities of the heart, are sent through the circulation of the lungs, and submitted to the influence of their action and the exposure to the atmospheric air.

When chyle is formed in the stomach and intestines, it is observed to consist of albumen, serum, globules, and salts: but the change which it may undergo by its reception into the lacteals, its being deposited in their glands, its mingling with the lymph, its agitation in the heart, have not been observed, though it is natural to suppose that by degrees it assimilates in its nature to that of the circulating blood, and does at last become perfectly similar by the operation of the lungs.

By the exposure of the circulating fluids to the atmosphere in the lungs a gas is absorbed, which becomes an active principle in the blood, and from the blood is communicated to the solids.

That the blood of an animal has properties which distinguish it from mere matter we readily allow; but to say that it possesses life is to use a term in which few will acquiesce. It possesses properties while circulating in the vessels distinct from those which it shews out of the body; and these do not depend on the agitation and incessant motion, nor on the degree of heat, nor on any similar circumstance, but apparently on some secret influence which the vessels exert over it. The analysis of the blood by the chemists holds out to us little hope of advancing in the knowledge of the œconomy of a living animal. Chemistry, when applied to the ana-



lysis of animal matter, leaves its devotees in a perplexity of knowledge and discoveries which have no end, and which point to no conclusion.

There are produced from the blood a variety of fluids by organs which are called glands, and the formation or separation of these fluids is secretion. But the solid parts of the body ought to be considered as secretions equally with the matter which flows from the ducts of glands. For there is formed and deposited from the blood, during the round of its circulation, bone to support the incumbent weight of the body; muscular fibre, to give it motion; as well as all the other variety of solids and fluids. The only difference betwixt these solid depositions from the blood and the glandular secretions is, that the former are still within the influence of the vascular system, and that they are decomposed and re-absorbed, conveyed again into the mass of circulating fluids before they can be finally expelled from the body.

The chemists have observed the division of animal bodies into solids and fluids, but the subdivisions of these are very inaccurate. The fluids they have distinguished into three classes; 1st, Recrementitious humours, which go to nourish and support the body; 2dly, The excrementitious fluids, which are carried out of the body by certain emunctuaries; and the 3d are of a compound nature, being partly recrementitious and partly excrementitious. We must observe, however, that the fluids enumerated under these heads shew it to be a very incorrect arrangement. The *first* division comprehends the fat, the marrow, the matter of internal perspiration, and the osseous juice. The

*second*

*second* comprehends the fluids of insensible transpiration, the sweat, mucus, cerumen, urine, fæces. And the *last* division comprehends the saliva, the tears, the bile, the pancreatic juice, the gastric and the intestinal juice, the milk, and the seminal fluid. To attend to their arrangements of the solid parts of animals would be equally far from serving any useful end; for they have thrown together parts so discordant in function and so unlike in structure that they can be of no use in a general view of the œconomy, and cannot in chemical analysis shew a uniform result\*.

Perhaps all the correctness to which we can at present pretend is some such division as this. Besides forming the solid mass of the animal body, these secretions are drawn from the blood: fluids which are subservient to the assimilating of new matter to the system; fluids which are useful in preserving the mobility of parts; and, lastly, the secretions which convey away the waste and debris of the body, which is successively replaced by the apposition of new matter.

From this short view of the system we understand how incessantly the powers are spent in action, and the fluids exhausted by deposition and secretion, and how essential to life the functions of those parts are which act upon and assimilate the food. It is the consideration of these parts which forms the subject of the first section of the present volume. As in the consideration of these functions the structure of the glandular organs becomes a chief subject of inquiry, it will be natural at present to consider in a general way the opinions

\* See Fourcroy's Analysis of Animal Substances.

which

which have been entertained regarding the structure of glands.

The peculiar nature of that organization by which the several secretions are formed, has hitherto eluded absolute proof by experiment or dissection. It is imagined that there are some organs which do little more than separate the parts of the blood like to the exudation by exhalant arteries. But neither in the exhalant arteries nor in the simpler organs can I imagine a simple straining of the blood, but rather that the same principle influences all, and that the several varieties of secretion depend upon a modification of the action. It would appear that the fluids in circulation and the vessels containing them must reciprocally affect each other: we know that a change on the state of the circulating fluids will alter the nature of the glandular action, and an excitement of the gland will still more powerfully change the nature of the secretion; the active power of the solids appearing to be an agent which controls and directs the chemical affinities.

We are struck with the variety of form in the secreting organs. We see a simple surface pouring out its fluids; or a simple canal into which the arteries throw out the secretion. We find again the secreting vessels and their ducts convoluted and massed together forming proper glandular bodies; of which kind are the solid abdominal viscera.

When we dissect the glands we do not find them to have a similarity in structure. Thus the substance of the liver, the kidney, the testicle, &c. are quite unlike, and as their secretions are different so are their sym-

pathies: the effect of disease upon them, and the consequences of medicine operating through the general circulation will be to attach to one individually, leaving the others in their accustomed action. Glands are different not only in their outward form, their general appearance when cut into, and the manner of the connection of their parts, but also in a remarkable manner in the length, size, and form of their vessels and ducts.

In considering the opinions of physiologists or anatomists regarding glandular secretion, and the structure of glands, we find in the first instance that the old physicians contented themselves with saying that the glands or viscera possessed a peculiar power to select and separate the fluids from the blood. The next class had recourse to hypothesis: they spoke of the separation of certain parts by means of fermentation \*, or by a kind of filtering through the pores or vessels of glands; that these pores allowed only particles of a particular size or figure to pass them †. It was opposed to this hypothesis, that the thinner fluids must have run through the organs destined for the grosser secretions. But when a theory such as this is received no argument nor proof seems necessary to overthrow it. Resting upon authority alone, it stood until it was overturned by the fashion of new doctrines: one equally puerile was raised upon its overthrow.

We observe, says the founder of this theory ‡, that wet or oiled paper will only transmit fluid of that

\* Van Helmont. Vieussens, &c.

† Charleton, Descartes, Borelli, Verheyen, &c. &c.

‡ Winflow. Helvetius.

kind

kind with which it is previously imbued, it will not transmit the oil when wetted, nor will the water make any impression on the paper when previously oiled. Upon these facts are to be raised a theory of secretion ! Betwixt the secreting vessels and the ducts, in the peculiar tissue of which glandular structure consists, there is interposed a fluid of that particular kind which is required to be secreted, and when the blood is driven against this tissue so imbued, no fluid but of a nature resembling that already deposited can be transmitted. By this hypothesis they explained secretion, making it to depend on the attraction and repulsion of the particles of the blood by fluids previously secreted. We may surely leave this class of physiologists accounting for the original deposition of the fluids in the glands without a wish to search with them into the mystery of glandular secretion. Commentators on this theory, by taking into the system the action of the nerves, indicated that they did not altogether forget that the body was alive \*.

Another set of physiologists attributed the whole effect of secretion to the velocity of the blood in the glands or secreting vessels † ; others, to the length and curves of the vessels, and their action upon the fluids. Again, others have been satisfied with the round assertion that the vital action was the essential cause of secretion. This, it ought to be understood, must be universally acquiesced in, while yet there may remain an inquiry as to the apparent structure of glands.

\* *Conor, Tentamen epistolare de Secretione.*

† *Boerhaave, Pitcarne, &c.*

Disappointed in obtaining an unexceptionable general theory of secretion, we are only enabled to conclude, that while a power exists in an animal body, directing its actions, perhaps both in the solids and fluids, and particularly in the mutual influence which they exert, the form, length, and activity of the vessels and ducts give occasion to the greater or less degree of intricacy in the operation of the principles upon which the secretion depends.

Let us then attend to the observations of the strict anatomists, and to the appearance which the GLANDULAR VISCERA present under the knife.

It is not perfectly clear what the older anatomists meant by the expression Parenchyma. It would appear however to have saved them the trouble of investigation, and all abstruse speculation. They meant flesh, yet not muscular substance, but such as the liver presents. This matter they seem to have conceived to be formed by the blood. Thus Higmore describes the liver to be formed of the blood of the umbilical vein: the opinion originally of Erasistratus.

Previous to the time of Malpighi it is fruitless to trace the opinions of anatomists regarding the structure of glands. He was the first who sought to throw light upon this obscure subject by anatomical investigation, and he made a more rapid progress than has been done by any man since his day. If we take into consideration the difficulties he had to encounter in a new field, and the prejudices of the learned with which he had to combat, his merits will be found greater than even those of Ruysch. The opinions of Malpighi were received by those who, forsaking the authorities of names,



names, saw the importance of the study of anatomy. Ruysch himself gave credit to the opinions of Malpighi in the early part of his life. But Ruysch's more attentive observations being contradictory to those of Malpighi, his maturer judgment rejected that anatomist's proofs, and with a boldness in which he was never remarkably deficient he invented a new theory, or at least alleged new facts, and swayed men's opinions with an absolute authority.

MALPIGHI was an Italian, and born near to Bologna. Whilst yet a young man, being sunk under the accumulation of family distress, absorbed in grief, and lost to the consideration of his interest, he received comfort and assistance from his master, who urged him to embrace the medical profession. His progress was rapid. After studying at Padua, he was called to fill one of the chairs in Bologna. He was then solicited by Ferdinand II., Duke of Tuscany, to be professor in the university of Pisa. Here he was associated with liberal men; and now only in his second professorship did he learn to despise the scholastic learning of the time, and betook himself to experiment as the only means by which philosophy could be raised from the oppressive barbarism of the schools. Malpighi and Borelli were associated; they dissected together; they suggested thoughts to each other; they doubted, and canvassed freely each other's opinions; and were to each other an excitement and encouragement to perseverance and industry. They were supported by government; popular in their teaching; while they collected round them the learned men of the time. This was the origin of the famous Academy del Cimento. Malpighi was, after this, professor

feffor in Meffene, and died in the Quirinal palace at Rome of a stroke of the apoplexy \*, after having been some time physician to Pope Innocent XII. Malpighi had many enemies, and even some of his colleagues were animated against him with a dishonourable jealousy. Many laughed at his studies and occupations, as frivolous and absurd. Something must be allowed for men who had laboured with diligence to become learned; for these, his opponents, had passed their lives in the study of the Arabian writers. With them studies were enforced which held science in subjection; studies which, in place of invigorating, served only to chill and paralyse exertion, and retard ingenious investigation. Even Borelli, but from other motives, opposed and censured some of the dissertations of Malpighi.

Malpighi has been considered as the inventor of this department of anatomy, which the French, curious in distinctions, have called the analytic method. He shewed the impropriety of the term Parenchyma, as applied to the substance of glands. He proved that the lungs, for example, (which they also called parenchymatous,) were not fleshy, and had no resemblance to the glandular viscera of the abdomen. He taught, that though glands are smooth on their outer surface, they consist of lobules connected by cellular membrane: and, upon a still more minute investigation, that they consist of innumerable little folicules or sacs; that these are interposed betwixt the arteries which convey

\* Two pounds of coagulated blood were found in the ventricles of his brain by Baglivi.



the fluids and the excretory ducts going out from them; that the arteries, or the vasa afferentia, after ramifying and encircling these bodies, pierce them and secrete the particular fluids into them. On other occasions he describes these little glandular bodies as applied to the ramifications of the arteries, like fruit hanging by the branches of a tree.

Malpighi threw in his liquid injections; dissected and examined with the microscope; made careful observations and experiments on living animals; and lastly, attended in a particular manner to the phenomena of disease. By disease no doubt parts swell out and are magnified, and become distinct; but it is not a test of the natural structure, or implicitly to be trusted to.

*Scheme of Malpighia opinion.*

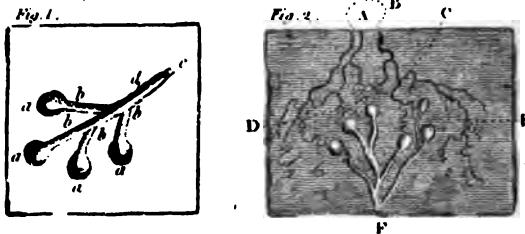


Fig. 1. Boerhaave's plan of Malpighi's doctrine, *a a a* folliculos glandularum simplicissimarum denotat. *b b b* singularia emissaria cuique utriculo *a*, propria atque in communem canalem excretorium *d, c*, suos

fuos humores demittentia qui tandem per hujus aperturam c, emittantur.

Fig. 2. is a scheme farther to elucidate the opinions of Malpighi. A, an artery entering a portion of a viscus. B, the returning veins. C, the branch of communication betwixt the artery and vein which serves to circulate the blood, and convey a part into the veins. D, another division of the artery, which after various playful meanderings terminates in the follicle or little glandular bag E. F, the ducts which receive the secreted fluid from the follicles.

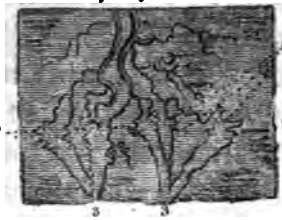
RUYSCH studied at Leyden under Van Horne, and at a very early age attached himself to anatomy and botany. At this time he brought himself into notice by a defence of the professors against one Bilsius, who, although he was learned and acute, had attacked them with all the weapons of a Charlatan. Returning to his native country, he was raised to the professorship of anatomy and botany in Amsterdam. It was here that Ruysch made those discoveries in anatomy, and that wonderful and sudden progress in practical anatomy, which not only raised him above his contemporaries, but has been the admiration of all since his time. Though new and various methods of preparing the body have been discovered since the time of Ruysch, yet there has been no approach to the elegance with which he displayed the structure of minute parts. It has been said that, while others preserved the horrid features of death, Ruysch preserved the human body in the softness and freshness of life, even to the expression of the features. We must no doubt ascribe some part of this encomium to the exaggeration

naturally arising from the novelty of the thing. But as to his superiority in the manner of displaying the minute vessels of delicate parts, and his methods of preserving the parts in liquors, transparent and soft and so as to float in their natural folds, there can be no doubt. Neither can the minuteness and success of his injections be denied: we have too many occasions in which we must resort to the catalogue of Ruysch's museum for the true anatomy, to doubt his great success, or to question the truth of those encomiums which have been bestowed upon him.

Kings, princes, ambassadors, and great generals, but more than these, all the learned men of the time, crowded to the museum of Ruysch. We must not blame him if, whilst others were merely speculating about the structure of parts, he, surrounded by so princely a museum, should simply have laid open his cabinets, and bid them satisfy themselves whether or not he was right. Ruysch's preparations went to contradict the opinions of Malpighi. His injections, pushed more minutely, showed those round bodies which are to be seen in some of the glandular viscera (and which Malpighi took to be little bags into which the secreted fluid was poured) to be merely convoluted arteries. Ruysch taught, that the minute arteries after making these convolutions terminated in the beginning of excretory ducts; that there was no substance or apparatus interposed, but that the vessels and ducts were continuous. His opinions being formed upon the strength of more minute preparations, and a superior dexterity of anatomical investigation, few anatomists chose to be outdone, or to acknowledge that they could not see

what he saw. This I believe to be one reason of the rapid progress of Ruysch's opinions.

*Scheme of Ruysch's opinion.*



1 1 The smaller arteries which do not enter into follicles, but are convoluted. 2 2 The appearance of bodies or bags, but which are merely owing to the convolutions and tortuous figure of the arteries before they terminate in the excretory ducts. 3 3 Excretory ducts or vessels formed by the continued extreme branches of the arteries \*.

\* Ruysch's doctrine again was thus opposed: " Ruyschius  
" auget arte sua replendi extensionem vasorum ultra naturalem  
" magnitudinem. Ruyschius arte sua destruit glandulas; dein  
" negat. Ruyschius negat omnes glandulas. Melius est & tu-  
" tius omnia hæc demonstrare in cadavere recenti." F. Ruysch  
Epist. ad Vir. Clar. Her. Boerhaave, p. 50.

It may be farther observed, that it was not in the mere fact of there being follicles, in which Malpighi and Ruysch differed; for the latter conceded that there were hollow membranes, but contended that these were not glands. Their difference of opinion is expressed in the following words of Ruysch: " Adeoque discrepantia inter magnum illum virum et inter me est, quod ille putat humores delabi in glandulas dictas simplicissimas,—ibi foveri, mutari: Ego puto, quod arteriæ ultimæ succos faciant, & factos ibi deponant."

The opinions of Malpighi and Ruysch have held the schools in perpetual controversy; most anatomists however leaning to the authority of Ruysch. There follows these a crowd of French academicians, who, with Boerhaave, may be considered as mere commentators on the original authorities of Malpighi and Ruysch. Some of these argue for secretion by continuous vessels, and contend that the arteries terminate in the excretory ducts; others, that the secretions are made into follicles; and some, as Boerhaave, insist that both are right in their observations, and in the proofs which they have adduced, that secretion is in part performed by continuous vessels, partly by a more intricate glandular apparatus.

As the forms of the parts which throw out secretions have an infinite variety, it may be useful in this introductory view to point out these varieties, and their appropriate names\*. In the first place, although in general language the term gland implies a secreting body, yet this does not follow from the definition of that word. According to Hippocrates, it is a tumid round body, soft, smooth, and shining. Many such bodies, and which we call glands, have no excretory ducts, and do not secrete a fluid; while most secreting parts admit of no such definition. When, again, we admit the definition of authors who have taught their peculiar opinions regarding their structure, we have a still less admissible description.

\* The terms acini, cotulæ, cryptæ, folliculi, glandulæ, lacunæ, loculi, utriculi, have been almost promiscuously used; being so many names for bundles, bags, bottles, holes, and partitions.

Thus Malpighi defined a simple gland to be "*Membrana cava cum emissario*;" and Ruysch says, "*Glandulæ nullæ componuntur ex sola membrana cava cum emissario, sed præcipue ex vasis.*"

These definitions of glands being optional and uncertain, it is necessary to use names appropriated to the several varieties of form in secreting parts. Indeed the term gland is inadmissible as conveying any knowledge of the minute parts of which the viscera are composed.

We must observe, however, that there is a division of glands still in use into *conglobate* and *conglomerate*. The first implies a gland simple in its form, the latter a gland having the appearance of an assemblage of several glands\*. Now there is no gland that has not more or less the appearance which is described by conglomerated; that is, consisting of several parts, united by cellular membrane; and the distinction is attended with no advantage.

*Acini* form the last sub-division which we observe in the viscera, as in the liver; they are round bodies, not regularly invested with membranes, and which can be teased out into parcels of minute vessels †.

\* As the salivary glands and the pancreas. Farther, the lymphatic glands are generally called conglobate glands, being smooth and apparently simple in their structure; but these, when injected, take exactly the appearance which should naturally be described by the term conglomerate, consisting of many little cavities. These lymphatic glands, belonging to a distinct system, require no farther particular definition to distinguish them.

† See farther of the acini of the liver for example.

connect the knowledge of the internal parts with the outward marks of the belly, it has been long customary to mark certain arbitrary divisions on its surface, which are called regions.

The **EPIGASTRIC REGION** is the upper part of the belly, under the point of the sternum and in the angle made by the meeting of the cartilages of the ribs with the sternum. Upon the sides under the cartilages of the ribs are the **HYPOCHONDRIAC REGIONS**, or the right and left hypochondrium. These three regions make the upper division of the abdomen, in which are seated the stomach, liver, spleen, pancreas, duodenum, and part of the arch of the colon. The space surrounding the umbilicus, betwixt the epigastrium and a line drawn from the crest of one os ilii to the other, is the **UMBILICAL REGION**. The **HYPOGASTRIC REGION** is of course the lowest part of the belly, consisting of the angle betwixt the umbilical region, the spines of the ossa ilii and the pubis. The two lateral spaces betwixt the false ribs and the spine of the os ilii are the **ILIAC REGIONS**, or the **LOINS**.

#### OF THE PERITONEUM.

THE Peritoneum, like all the other membranes of the body, consists of an expansion of dense cellular membrane; yet it is what is called a proper or simple membrane; being a white firm thin contexture of cellular substance, in which no fibre or striated appearance is to be observed \*. By its outer surface it adheres to

\* The meaning of some anatomists, saying that the peritoneum is a double membrane, will be seen below.

the





*Plan Drawing of the Abdomen, Showing the Inflections of the Peritoneum.*



Drawn by Chas. Bell.

Engraved by Skelton.

Published for Longman & Ross, May 9<sup>th</sup> 1804.

the adipose membrane, on the inside of the abdominal muscles, and to the surface of the several viscera; its inner surface is smooth, and forms no adhesion while the parts are sound and healthy; its outer surface is looser in its texture, and by the splitting of its lamina it degenerates into the common cellular membrane.

The cellular membrane on the outside of the peritoneum is in some places short, firm, and dense; as on the liver, the spleen, the uterus, and the intestines: but it is longer, lax, and fatty, where it attaches the peritoneum to the muscles and tendons of the abdomen.

The peritoneum has no termination; or it is a sac; yet so curiously is it involved with the viscera, that though we say the viscera are contained in the abdomen, yet, accurately speaking, they are without the peritoneum, and consequently lie not in the abdominal cavity\*.

The peritoneum is expanded on the lower surface of the diaphragm; and at some of the interstices or perforations of that muscle or its tendon it comes in contact with the pleura, and adheres to it by cellular substance. From the diaphragm the peritoneum is reflected off to the liver, forming the ligaments of that viscus, and, expanded over its surface, it forms its outer membrane. From the diaphragm it is also sent off upon the œsophagus and stomach, and prolonged to the spleen on the left side (as it is to the liver on the right) so as to form the ligaments of the spleen.

\* See Plate I. and the explanation.

The

The aorta, the great vena cava, the thoracic duct, and the kidneys, are behind the peritoneum; that membrane being stretched before them. But the intestines are also in the same respect behind this general investing membrane; for it is merely reflected from the spine and psoas muscles, and from the great vessels running down upon the spine, so as to involve the intestines and form their outer coat. As it stretches towards the tract of the intestinal canal, it consequently involves the vessels of the intestines in its duplicature, and forms the mesentery.

The peritoneum also lines the abdominal muscles; it is reflected from the diaphragm upon the surface of the transversalis and rectus abdominis muscles. Here it is united to them by a loose adipose membrane, and from the abdominal muscles it is continued upon the inside of the pubes. From the pubes it ascends upon the bladder of urine; descends again behind the bladder; and there, making another reflection to mount over the rectum and form the meso-rectum, it leaves betwixt the rectum and bladder a particular sacculus.

From this detailed description we see that the peritoneum has no termination; that it is continued from the surface of the diaphragm to that of the abdominal muscles; from that over the bladder and rectum; from the rectum in the whole length of the intestinal canal; and from the intestinal canal up upon the diaphragm. We see then what is meant when it is said that it is a shut sac; we understand by the cavity of the peritoneum merely the inside of this sac; and that when distended with fluid, that fluid is contained betwixt the  
peritoneum

peritoneum lining the abdominal muscles and that part of it which invests or forms the outer membrane or coat of the intestines. This fluid, whether collected there by disease or thrown in by experiments, has no natural outlet, nor does it transude in the living body\*.

#### BLOOD-VESSELS OF THE PERITONEUM.

As the peritoneum is a membrane of great extent, and investing a variety of parts, its vessels come from many sources. It receives arteries and veins from the mammary vessels; from the phrenic and epigastric vessels; from the lumbar arteries and veins; and from the ilio-lumbalis, circumflexa ilii, renal, and spermatic arteries. It receives nerves from the intercostal, lumbar, and diaphragmatic nerves.

It would appear that disease has given rise to the opinion that the peritoneum has in it many little glands. This is controverted decisively by Morgagni.

\* Soemmerring, Corp. Hum. Fab. Contemp. Peritonei, § iii.

We not unfrequently find an accurate general description in authors, but some incorrectness in the subordinate detail; which throws back the ideas of the reader into confusion. Such is the enumeration of the holes or perforations of the peritoneum, “pour donner passage à l’œsophage, à la veine-cave,” &c. See *Anatom. Chirurg. par M. Palfin*. We see that there are no such perforations, that the œsophagus never enters into the cavity of the peritoneum, nor does the rectum pass out from its cavity. This was indeed explained by Fernelius in opposition to Galen. See a description of the inflexions of the peritoneum by Bartholin.—*Specimen Historiæ Anatomicæ Analect. Ob. I.*

## OF THE USE OF THE PERITONEUM.

THE peritoneum serves as a dense and outer coat to the abdominal viscera; conveys the vessels to them, as in the example of the mesentery; and, having its inner surface smooth and lubricated by a watery secretion, it allows the parts to lie in contact (they being strongly compressed by the surrounding abdominal muscles and diaphragm), and at the same time allows in the intestinal canal a capacity of motion without friction.

There is no internal surface or cavity, as it is called, of the living body, which is not moistened by an exudation from the vessels of the surface. Thus it is with the peritoneum. An exhalation from the extreme arteries bedews its surface, and is again taken up by absorbent vessels; so that it does not accumulate in health, nay even fluids poured into the abdominal cavity will be taken up by the absorbents \*. When the abdomen is opened in animals alive, or recently killed, as in the shambles, a vapour is seen to exhale from the peritoneum having a peculiar animal odour. Yet we ought not to say that this vapour is collected in the

\* See Nuck Sialograph. c. ii. p. 27.

*Qua copia in statu secundum naturam fecernatur dictu difficile est: ad uncias certe collecta aquula in sani hominis abdomine reperitur. (Kaawn, 543.) In homine, cui sponte abdomen sub umbilico ruptum erat ad quinque & sex libras de die effluebat, (Journ. de Med. 1757 M. Aug. ut denique 800 libr. effluerent).* This, however, proves nothing of the nature or quantity of the secretion; this has probably been an inflammation and abscess of the peritoneum, which, we have seen, pours out such a quantity of fluid, thin and serous, as quickly to drop through the bed-clothes upon the floor.

dead

dead body ; for before the opening of the peritoneum, or the death of the animal, it is not in a state of vapour, but is condensed into a watery exudation \*. I have seen, in the high state of inflammation of this membrane, pus formed upon the surface without ulceration, and therefore, probably, from the same exhaling or secreting surface ; and coagulable lymph lying in flakes upon it. The increase of the serous discharge forms the common ascites ; but whenever the natural secretion or exudation from the peritoneum is altered, adhesions are apt to form.

One great use of the peritoneum is to retain the viscera in their place, says Haller ; for when it is wounded they escape, and sometimes with a sudden impetus, which makes it difficult to reduce or retain them †. But this is not from the want of the embracing of the peritoneum, but from the tendons or muscles which support the peritoneum being cut ; for when there is a deficiency in the support given by the abdominal muscles, or their expanded tendons, the peritoneum does not prevent the viscera from being protruded, but easily yields to their forcible protrusion, and forms a sac involving this hernia.

Nor do the processes of the peritoneum, which have received the name of ligaments, nor the mesentery, nor mesocolon, sufficiently resist the prolapsus of the viscera when they have escaped from the pressure of the sur-

\* This vapour I have seen arising from the intestines of the human body during the operation for hernia ; and also when the omentum and intestines have escaped in consequence of a wound of the belly.

† Element. Physiol. tom. ii. p. 380.

rounding muscles. Sufficient example of this we have in hernia of the intestines, in which the mesentery is greatly elongated, or in the displacement of the stomach, or in the prolapsus and procedentia uteri.

The peritoneum which forms the sac of hernia retains little elasticity, and does not shrink into the belly when freed from the outer adhesions; but the general peritoneum will allow great distension, as in ascites, and quickly contract to its former dimensions on the evacuation of the fluid; and so that part of the membrane which invests the stomach and intestines the bladder of urine and gall bladder, has considerable elasticity, since it suffers these parts to be distended and again returns to its former dimensions.

The consideration of the insufficiency of the peritoneum to retain the viscera leads us to attend to a circumstance of the greatest importance connected with the viscera of the belly. The abdomen is everywhere (except towards the spine) surrounded by muscles. Above we see the diaphragm; before, and to the sides, the abdominal muscles; and even below, the parts in the pelvis are surrounded and compressed by the levator ani, in such a manner that the whole of the viscera suffer a continual pressure. This pressure upon the viscera appears to be uniform and constant, notwithstanding the alternate action of the abdominal muscles and diaphragm as muscles of respiration: but it must be occasionally very violent during exertions; in pulling, for example, or in straining, as a sailor must do in working of the great guns, or when pulling at the oar, or when balancing himself upon his belly over the yard-arm. And indeed by such violent and general compression

compression of the viscera of the belly, ruptures are sometimes produced, of the worst kind, and followed by the immediate train of urgent symptoms.

The viscera having in general delicate outer coats, and no ligaments capable of supporting them, and being very vascular, require the support of this pressure of the surrounding muscles; and the great venous trunks which take their course through the abdomen are in a particular manner indebted to the pressure of the abdominal parietes. We must recollect also the bad consequences which result from the sudden relaxation of the abdomen; as in women after delivery, or in consequence of withdrawing the waters of ascites without due compression of the belly; languor, faintness, and even death, are sometimes produced, apparently by the balance of the vascular system being destroyed.

Some good authors in former times have described the peritoneum as a double membrane\*. This was no farther a mistake than as they considered the cellular membrane, which lies without the peritoneum, as a part of it. It is necessary to recollect this in order to understand the meaning of their calling the sheath of the cellular membrane, which accompanies the vessels passing out from the abdomen, productions of the peritoneum. The vaginal productions of the peritoneum are the sheaths of the common cellular substance which accompany the aorta and œsophagus into the posterior mediastinum; or which give a bed to the

\* See *Anat. Chirurg* par M. Palfin, tom. II. p. 35. and note *a*.  
spermatic



spermatic vessels, or passing under Poupart's ligament accompany the vessels of the thigh. They are improperly termed productions of the peritoneum.

The proper productions or prolongations of the peritoneum are of a very different kind; they are the mesentery and omenta and ligaments: but, as I have explained in general how the mesentery and ligaments are formed by the peritoneum, and as they must come presently to be considered more particularly, we treat no farther of them here \*.

#### OF THE OMENTA.

THE Omenta are considered as secondary processes of the peritoneum, because they are not formed by the peritoneum reflected off from the spine upon the intestines, as the mesentery is,—it being a primary process; but they are reflected from the surface of the stomach and intestines. Anatomists distinguish the omentum majus,—colico-gastricum: the omentum minus,—hepatico-gastricum; omentum colicum; and lastly, the appendices epiploicæ.

The OMENTUM, or EPIPLÖON, meaning thereby the great omentum, is a floating membrane of extreme delicacy, expanded over the surface of the small intestines, and attached to the great arch of the stomach and intestinum colon. Although this membrane be of extreme delicacy and transparency in the young

\* See farther of the peritoneum under the head Mesentery, Mesocolon, Descent of the Testicle, &c.

subject,

subject \*, yet it is much loaded with fat, and appears transparent in the interstices only; and in advanced age it loses much of its delicacy, and acquires a degree of diseased consolidation or firmness, and is often irregularly collected into masses, or adheres preternaturally to some of the viscera.

The omentum majus hangs suspended from the cellular connection betwixt the arch of the stomach and the great transverse arch of the colon; or rather it forms that connection betwixt the stomach and colon. It consists of two membranes, or is as a sac collapsed and hanging from the stomach and colon †, one of the sides being the peritoneum reflected off from the œsophagus and alongst all the great arch of the stomach, and the other that which comes from the arch of the colon. And further, as each of these lamina may be supposed to consist of two lamina; for example, where the omentum is formed by the meeting of the peritoneum from the lower and upper surfaces of the stomach; these two, meeting, form the upper lamina: and as, where the lower layer of the omentum comes off from the colon, it is also formed by the peritoneum reflected in the same manner; so with some truth the omentum

\* *Præterea tenerrimas esse ut nulla membranarum humanarum, retina oculi excepta, æque sit tenera.*

Haller, vol. vi. lib. 20. § 1. par. 12.

While its delicacy is remarkable in the young subject, the retiform vessels (vid. Ruysch. Ther. II. Q. V. Spegil. LVIII. &c.) have the fat accumulated in their tract as if it were thrown up by them to a side; but often the fat increasing obscures the vessels.

† *Marfupitum* the common term.—See Winslow, IV. § 352.

is supposed to consist of four lamina of membranes of extreme tenuity : but these four layers cannot be demonstrated. The great omentum extends from the bosom of the spleen transversely, until it terminates on the right side of the arch of the colon, where the omentum colicum begins.

The great omentum varies considerably in extent. In a child it is short ; in the adult further extended over the viscera : sometimes it reaches only to the umbilicus ; sometimes it is allowed to extend its margin into the pelvis, so that in old people it is very apt to form a part of the contents of hernia : often it is wasted and shrunk ; sometimes collected into masses leaving the surface of the intestines.

#### OF THE OMENTUM MINUS OR HEPATICO GASTRICUM.

THIS is a membrane of the nature of that last mentioned, but in general less loaded with fat. It is extended from the liver to the lesser arch of the stomach. It passes off from the lower surface of the liver at the transverse fossa ; from the fossa ductus venosi ; invests the lobulus spigellii ; involves the branches of the cæliac artery ; and is extended to the lesser curvature of the stomach and the upper part of the duodenum \*.

\* “ Macilentius est, et vasa habet minora.” Winslow. Haller. Indeed it seems rather to answer the general purpose of a cellular membrane conveying vessels, than the purposes of the omentum majus.

## OMENTUM COLICUM.

THIS is a continuation of the great omentum upon the right side of the great arch of the colon, where it rises from the caput coli; but it seldom extends its origin from the colon the length of the caput coli. It can be inflated like the great omentum.

APPENDICES EPIPLOICÆ, OR OMENTULA INTESTINI  
CROSSI.

THESE are little fatty and membranous processes which hang pendulous from the surface of the colon: they are of the same texture and use with the greater omentum and right colic omentum.

We have mentioned that the omenta are double reflections from the peritoneum, and consequently they may be inflated so as to demonstrate them to be perfect sacs. To do this it is not required to puncture any part of them, for there is a natural opening by which the whole may be inflated in a young subject, and in a healthy state of the viscera.

This natural opening into the purse or sac of the omentum is betwixt the membrane involving the vessels and ducts of the liver, and the peritoneum, where it invests the vena cava betwixt the neck of the gall bladder and the first turn of the duodenum, or where the lobulus caudatus hepatis touches the duodenum. By introducing a blow pipe into this natural fissure the foramen of Winslow, the omentum minus may be raised: the gastro colic, and colic omenta may be inflated. This opening serves as a communication be-

twixt the cavities of the omentum and the general peritoneal cavity; but I am inclined to think it is very frequently destroyed by adhesions \*. As this opening points towards the right side, Dr. Monro thinks it a sufficient reason for introducing the trochar on the right side in the operation of tapping for ascites, (contrary to the usual caution of avoiding the liver, which is so often diseased in this case,) and that by operating on the left side he thinks the water will not be allowed to flow from the sac of the omentum †. It appears to me that it will flow equally well from whatever point of the belly the water is drawn.

There is a considerable variety in the form of the omentum of animals ‡, but still they seem to shew the same provision of involving the intestines, filling up the inequalities which arise from the rounded forms of the viscera, and still further lubricating and giving mobility to the intestines §. The surface of the omen-

\* Winflow, Duverney, and Haller.

† *Quer.* If I should say to a patient, By puncturing here I am in danger of thrusting this instrument into your liver; by introducing it here there is less possibility of any such accident, though I may not draw off all the water; what would be her answer?

‡ Haller Element. Physiol. tom. vi. lib. xx. § 2 and 3.

§ We must not suppose that because a mad-man slabs himself in the belly, and there is afterwards found coalition of the intestines to the wounds, the omentum has not done its office, (see Boerhaavii Praelectiones, vol. i. § 45.) no more can we give credit to the tale told by Galen (De Usu Partium, l. iv. c. 9.) of the gladiator who lost part of the omentum, and ever after had a coldness in his guts! at least we cut out a great part of the omentum from a man without any such sensation being the consequence now-a-days.

tum,

tum, however, seems merely to furnish a fluid exudation like the general surface of the peritoneum; at least the idea which has been entertained of the oil or fat exuding is quite improbable\*.

The use assigned to the omentum of being subservient to the function of the liver is deservedly neglected†.

\* "Et dum halitu pingui & ipsa obungit & peritoncum."  
Hale loc. cit. Boerhaave, &c.

† Viz. by supplying a gross oily matter to the venæ portæ.

## C H A P. II.

## OF THE MEMBRANEOUS VISCERA OF THE ABDOMEN\*.

**H**AVING understood the nature of the general investing membrane of the abdomen, and what is meant by its cavity and its processes, we take a general survey of the œconomy of the viscera, before entering upon the minute structure of the parts individually.

The organs destined to receive the food, and to perform the first of those changes upon it which fit it (after a due succession of actions) for becoming a component part of the living body, are the stomach and intestines primarily; the glandular viscera, the liver, pancreas, (and in all likelihood the spleen,) as subservient or secondary organs. I have been accustomed in my lectures to divide these parts into the membranous or floating viscera, (viz. the whole track of the intestinal canal) and the glandular viscera; or perhaps, what is still better, they may be distinguished into those parts which have action and motion, and those which are quiescent or possessed of no power of contraction. Thus the stomach, intestines, gall-bladder, and bladder of urine (though this belongs to the

\* Although the term Viscus implies more particularly the fleshy or solid contents, as the heart, liver, kidneys, yet we use it in general for all the parts contained in the great cavities.

pelvis)

pelvis) have muscular coats, and the power of contracting their cavities ; while the liver, spleen, pancreas, and kidneys, have no muscularity but in their vessels and excretory ducts.

This division of the viscera may lead to important distinctions in pathology. During inflammation, it is observed, that though the parts possessing a power of contraction may sometimes lie inactive without pain, yet in those parts when roused to action there is excruciating pain. On the other hand, it often happens that the glandular and solid viscera are the seat of long continued disease, which is attended only with a dull or low degree of pain ; while the anatomist is often struck upon examining the body after death with the wide ravages of the disease.

We divide the intestinal canal into three parts ; the stomach, the small intestines, the great intestines. The small intestines are subdivided into the duodenum, jejunum, and ileon. The great intestines are subdivided into the cæcum, colon, and rectum. The stomach is the seat of the digestive process : in the duodenum the food receives the addition of the secretions from the liver and pancreas, and is still further adapted to animalization ; in the long tract of the jejunum and ileon the nutritious part is absorbed ; and in the great intestines the effete matters are carried slowly forward, and at the same time suffer a further absorption of their fluid contents, until as fæces they lodge in the rectum or last division of the canal.

From this view it is apparent that as each division of the intestinal canal is marked by some peculiarity in its use or function, we must carefully examine their



minute structure as individual parts, at the same time that we do not allow ourselves to forget the universal connection, the integrity of the circle of actions, and the œconomy as a whole. With this intention, following the course of the food, and with a view also to connect the present subject with the last part of vol. iii. we treat first of the œsophagus.

## SECTION I.

### OF THE ŒSOPHAGUS.

THE œsophagus or gullet is a cylindrical tube, partly membranous and partly fleshy; which is continued from the pharynx down behind the larynx and trachea and close before the spine. Still continuing its course in the back part of the thorax, it perforates the diaphragm, and expands into the upper orifice of the stomach; its use is to convey the food by deglutition into the stomach.

Although with many authors I call it a cylindrical tube, and it may take this form when dissected from the body and inflated, yet during life it lies collapsed with its inner membrane in close contact, and it transmits the morsel only by the continued succession of the contraction of its fleshy coat.

The upper part of this tube is called the pharynx. It may be described as expanding funnel-like, and is attached to the occipital bone, pterygoid processes of the sphenoid bone, and jaw bones; and further down it is kept expanded upon the horns or processes of the os hyoidis. This bag is very fleshy, being surrounded  
with

with muscular fibres, which take their origin from the neighbouring points of bone ; as the styloid process, the horns of the os hyoidis, the thyroid cartilage \* ; by which it is enabled to grasp and contract upon the morsel when it has been thrust by the tongue behind the isthmus faucium. This strong tissue of muscular fibres which surrounds the pharynx, is continued down upon the Œsophagus in the form of a sheath, which has been called vaginalis tunica.

#### STRUCTURE OF THE ŒSOPHAGUS.

I BELIEVE we can with propriety enumerate no more than two proper coats of the Œsophagus ; its muscular and internal coat ; for that which is sometimes considered as the outer coat, is only the adventitious cellular membrane, and the nervous coat is merely cellular tissue connecting the muscular and inner coat.

The MUSCULAR COAT of the Œsophagus greatly surpasses in strength and in the coarseness of its fibres any part of the whole tract of the intestinal canal. There may be very distinctly observed in it two layers of fibres ; an external one consisting of strong longitudinal fibres, and an internal one of circular fibres. These lamina of fibres are more easily separated from each other than those in any other part of the body †.

But

\* See vol. i. p. 228.

† It appears that the Œsophagus can be ruptured in two ways : across, by the tearing of the longitudinal fibres ; and longitudinally, by the separation of the longitudinal fibres. This, though a rare accident, takes place in violent vomiting or straining to vomit ; and, in the first instance, the tearing across of the Œsophagus

But an idea is entertained that the one set of fibres, the circular and internal ones, are for contracting the tube, and the outer ones for elongating and relaxing it. I believe on the other hand that they contract together, conducing to one end, deglutition\*.

What is called the TUNICA NERVEA is the cellular connection betwixt the muscular and inner coat, and is very lax, insomuch that the muscular coat and the inner coat are like two distinct tubes, the one contained within the other, and but slightly attached. This appearance is presented particularly when the œsophagus is cut across.

The INNER COAT of the œsophagus is soft; glandular villi are described as being distinguishable on its surface, and it is invested with a very delicate cuticle to dull the acute sensibility, and prevent pain in swallowing. It in every respect resembles the lining membrane of the mouth. The power, however, which the œsophagus seems to possess of resisting heat depends not on the insensibility bestowed by the cuticle, but is owing to the rapid descent of the hot solids or liquids swallowed; for when they happen to be detained in the gullet they produce a very intolerable pain. This inner coat has an exhaling surface, like the rest of the body, with particular glands to secrete and pour out

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phagus seems to be the effect of the action of the diaphragm on the œsophagus. By this accident the fluids of the stomach are poured into the cavity of the thorax.

\* See farther of the muscular coat of the intestines. "It was at one time supposed that the muscular fibres of the œsophagus had a spiral direction." See Verheyen, and Morgan. *Adversar.* iii.

that

that mucus which lubricates the passage for the food \*. The inner coat is capable of a great degree of distention, but it is not very elastic, or at least contraction of the muscular coat throws it into longitudinal folds or plicæ †.

In the neck, the œsophagus lying betwixt the cervical vertebræ and the trachea, is at the same time in a small degree towards the left side. In the thorax it runs down betwixt the pleura of either side, where they form the posterior mediastinum. Here, even when it descends upon the dorsal vertebræ, the œsophagus lies rather to the left side; it then passes under the arch of the aorta, but quickly escapes from under its compression and rises on the right side of the aorta, and as it passes further down it gets more and more before the aorta. This is sufficiently apparent when we attend to the relation of the perforations in the diaphragm for transmitting the aorta and the œsophagus.

Behind the œsophagus, in the thorax, there are one or two lymphatic glands, which were understood by Vesalius to belong to the œsophagus. What deceived

\* These glands suffer ulceration and scirrhous hardening, and are a terrible cause of difficulty of swallowing.

† Some part of the food lodging in the natural lacunæ of the œsophagus, or some solid body, as the stone of fruit being received into them, has been the cause of a sac forming in the pharynx or œsophagus. And it has happened that such a sac, gradually and for years enlarging, has formed a bag, into which nearly the whole food, that should have passed into the stomach, was received, so as to oppress the œsophagus and occasion a lingering death. An example of this is to be seen in my museum.

him is an appearance generally to be observed in these glands. The lymphatics, or the small branches of veins, are generally filled with a black matter, which, extending to the coats of the Œsophagus, resemble very much the ducts of the glands going to open into the Œsophagus\*.

The inner coat of the Œsophagus shows so very different a texture from that of the stomach, and this difference is marked by so very abrupt a line, as sufficiently to indicate that the fluids poured out from the Œsophagus are very distinct from those of the stomach, and have no power of digestion.

## SECTION II.

### OF THE STOMACH.

#### *Seat, Form, Displacement of the Stomach.*

THE stomach lies under the margin of the ribs of the left side, and chiefly in the left hypochondrium. Its greater extremity is on the left side, in contact with the diaphragm; but towards the right, the shelving edge of the horizontal lobe of the liver is betwixt it and the diaphragm. On the lower part it is, by the mesocolon and arch of the colon, divided from the small intestines; and to the greater extremity the spleen is attached by vessels and by the loose intertexture of the omentum. The stomach may be said to be

\* These glands in the posterior mediastinum are sometimes diseased, and enlarged so as to compress the Œsophagus and to cause so permanent an obstruction of deglutition as to kill.

a conical sac; the extremities of which being made to approach each other, gives it the curve of a hunter's horn, and gives occasion to the anatomist, in strict description, to remark these parts; the SUPERIOR or CARDIAC orifice into which the œsophagus expands; the LOWER or PYLORIC orifice, which leads into the duodenum: the LESSER AND GREATER CURVATURES of the stomach.

The lesser curvature of the stomach extends from betwixt the two orifices; includes in its embrace the spine, the aorta, and the small central lobe of the liver, while there is attached to it the lesser omentum. The greater curvature of the stomach is the outline of its distended belly, which rises above the arch of the colon, and is marked by the course of the gastro-epiploic vessels.

When the stomach is distended the lower orifice is nearly on a level with the upper one; but when the stomach is allowed to subside, it falls considerably lower; so that whilst the stomach is lying across the abdomen it is also tending obliquely downwards. The ensiform cartilage will be found to present commonly to the middle of the stomach; and the lower orifice, when in its natural situation, is opposite to the fossa umbilicalis of the liver: the upper orifice is kept constantly in one place from the stricter connection of the œsophagus with the diaphragm.

Both orifices of the stomach present backward, especially the upper one, while the lower one is pointed backward and downward. By the distention of the stomach the great arch is extended, the orifices are directed more backward and towards each other, and especially the greater extremity draws upon the œsophagus.

phagus. By these means I conceive that there is sometimes produced a difficulty of the stomach discharging its contents when greatly distended, the orifices being in a great measure turned from the œsophagus and duodenum.

The stomach being liable to frequent varieties in its degree of distention, the natural relation of parts must frequently be altered. It ought to be particularly recollected, that in the living body the stomach is supported and bound up by the intestines; so that the great curve presents: and the broad anterior surface which the stomach presents in the dead body is turned directly upward, and the inferior downward \*. By the collapsing of the stomach and the consequent falling down of the liver some have explained the sensation of hunger, conceiving that the uneasy sensation proceeds from the liver being allowed to hang upon the broad ligament †. From the great simplicity of mechanical explanation physicians have eagerly indulged in them, but it will in general be found that when they are applied to the explanation of the phenomena of a living body they are inadmissible.

#### OF THE COATS OF THE STOMACH.

THE coats or membranes forming the stomach are, the outer, the muscular, the nervous, the vilous, and the three

\* Thus the gastro-piploic artery presents directly forward. It has been wounded, and bled both into the stomach and outwardly. I should conceive it possible in such a case to tie the artery.

† Winslow.

cellular

cellular coats. For these subdivisions, however, I see no use, nor are they authorised by the natural appearance of the coats of the stomach. When there is a distinction in texture, structure, or function, and where these lamina can be separated, we should consider them as coats; but a mere intermediate tissue of vessels, or the connecting cellular membrane, are improperly considered as distinct tunics.

**FIRST COAT.**—From what has been already said of the peritoneum, it will readily be allowed that the outer coat of the stomach is formed by the peritoneum; a coat common to all the intestines. Were this not sufficiently evident in itself, it might be ascertained by dissecting the peritoneum from the cardiac orifice of the stomach, where it will be found reflected from the diaphragm. This coat is firm, simple in its texture, having no apparent fibrous texture, and smooth on its outer surface, with many minute vessels. Under the peritoneal coat is the first cellular coat, being in fact a short cellular tissue betwixt the peritoneal coat and the muscular coat.

**MUSCULAR COAT.**—The muscular coat of the stomach consists chiefly of two lamina of fibres; less distinct however than those of the œsophagus, or, in other words, more closely and irregularly connected. One set of fibres runs longitudinally, that is, from the one orifice to the other; the other set runs encircling the stomach; yet there are such irregularities that it is difficult in every place to recognize the two great and original divisions of fibres; and on this account in general three strata or series of fibres are described.



scribed \*. For an example of this apparent irregularity, there comes down upon the flat side of the stomach an irregular fasciculus of fibres, apparently from the longitudinal fibres of the cardiac orifice, and continued from those of the œsophagus, which yet take a course fairly encircling the stomach. They cannot be strictly said to belong to either the circular or longitudinal series, and in many places those which run longitudinally on the stomach seem to sink and lose themselves amongst the lower fibres, or are reflected into transverse fibres.

These muscular fibres of the stomach do not run in an uninterrupted course, but split, rejoin, and form a kind of retiform texture through which the coats beneath are at intervals discernible. This structure would appear to bestow a greater power of contraction on the stomach. The strong longitudinal fibres which are seen upon the œsophagus form the outer stratum of the muscular coat of the stomach, and they extend from the œsophagus and cardiac orifice in a stellated form along the upper curvature, and downward upon the great end or sacculus ventriculi. Then we have to observe a set of circular fibres, which forming rings upon the great end, extend over all the stomach, like the circular fibres of the arteries. These fibres do not each encircle the stomach entirely, but while their general direction is circular, they are so interwoven that

\* The most general opinion is, that there are three layers of fibres in the stomach. Some describe an external longitudinal series; a middle transverse stratum; and again the internal fibres running longitudinally. See Galeati Acad. de Bologne.

No one fasciculus can be followed to a great extent. These are called the TRANSVERSE FIBRES OR STRATUM; while the deepest stratum consists of the continued circular fibres of the œsophagus. These last fibres are strong upon the cardiac orifice, and may be presumed to form a kind of Isthmus; but they diminish as they are remote from the superior orifice. The lower or pyloric orifice of the stomach, however, is more carefully guarded by muscular fibres; having in the duplicature of the inner coats a distinct circular ring of muscular fibres.

The cellular tissue, being intermingled with the muscular fibres, connects and strengthens them, and gives the appearance of little white lines interwoven with the muscular fibres, and which some have described as small tendons\*. There is also to be observed a broad ligamentous band on the two flat surfaces of the stomach towards the pylorus. They are like the bands of the colon, but not nearly so strong or evident. They are formed by the denser nature of the cellular tissue, and more intimate union betwixt the first and second coats.

#### OF THE ACTION OF THE MUSCULAR COAT.

UPON considering the weakness of the muscular fibres of the stomach, and the membranous nature of the whole coats, it appears that the general action of the stomach is slow, regular, and by no means a forcible contraction; not an apparatus for triturating the food, but merely giving motion to its contents. But

\* See Winslow, sect. viii. p. 57.

regarding the extreme sensibility of the stomach, and the gradual and regular succession of action, much will be found that is worthy of attention. It should seem that the morsel is sent down into the œsophagus by a succession of actions, preceded by a perfect relaxation; and that when the food arrives at the superior orifice of the stomach, by the same relaxation preceding the contraction, the muscular fibres of the upper part of the stomach yield and receive the food compressed by the œsophagus. Attending to the form of the stomach, we see a provision for the reception of the food into the great sacculated fundus on the left extremity. And here we shall find that there is a greater profusion of vessels for the secretion of the juices of the stomach, and a set of muscular fibres, probably relaxing and yielding to receive the food, and excited to action only when the process of digestion has been in part or entirely accomplished. We have proof that when the food has remained the usual time in the stomach, and comes in succession to be presented at the lower orifice, if the stomach is healthy and the change upon the food perfect, the lower orifice is relaxed, and yields to the contraction of the muscular fibres of the stomach, and the contents of the stomach are passed into the duodenum: but if the food has been of an indigestible nature, it is rejected. The pyloric fibres refuse the necessary relaxation, and by the unnatural excitement an antiperistaltic motion is produced, and the matter is again thrown into the great end of the stomach, or rejected by vomiting. There is in the natural action of the stomach a stimulus, followed by a regular succession of motion in its fibres, conveying the contents from

the upper to the lower orifice of the stomach. Of this excitement and action we are not conscious ; but when the action is disordered by an unusual excitement, the lower orifice is not unlocked, the action becomes violent (the reverse of what naturally takes place), and pain or uneasy feelings are produced. Upon this principle may be explained the nausea and vomiting which take place at certain times after eating, when balls or concretions are lodged in the stomach. While the food lies in the greater extremity, or in the body of the stomach, and the ball or concretion with it, there is no great excitement ; but when it has suffered the necessary change, and is approaching to the pyloric orifice, this part, being as it were a guard upon the intestines, is suddenly excited, vomiting is produced, and the ball is thrown into its old place in the sacculus or great end.

This great sensibility, producing effects almost like intelligence, is apparent in the more common disorders of the stomach. We shall find the meteorismus ventriculi (the great distension of the stomach by flatus) existing for weeks, and yet the food passing in regular course through its orifices. We shall find very frequently food of difficult digestion lying in the stomach and oppressing its functions for days, while food more recently received may have undergone the actual changes, and have passed through the pylorus into the duodenum.

Owing to the same slow and successive action of the stomach, it often happens that ulceration and schirrus pylorus, or other obstruction of the lower orifice of the stomach, is attended with pain, nausea, and vo-

miting, only at stated intervals after taking food ; *i. e.* at the time in which the food should be sent into the intestines in the natural course of action.

The muscular fibres of the stomach are excited by stimuli, applied, not to their substance, but to the contiguous coats ; and betwixt the delicate surface of the inner coat and the muscular fibres there is the strictest sympathy and connection. The same connection holds in a less intimate degree betwixt the outer coat and the muscular fibres ; for when a part on the surface of the stomach of a living animal is touched with acid or stimulating fluids, the part contracts \*. The stomach is considered as less irritable than the intestines, because it is alleged that a stronger dose of a medicine is required to prove emetic than to act as a purgative ; but we ought to consider that the action thus excited in the intestines is merely an acceleration of their secretions ; but vomiting is the interruption of the usual action, requiring such a violent excitement as to invert the natural action.

But there is something more than this ; as the function of the stomach differs from that of the intestines, so may the quickness of their action. Thus in the stomach a gradual change is to be produced upon the food, requiring time and a slow degree of motion ; but in the intestines there is a greater agitation of their contents, and a quicker action of their coats, to bring

\* “ In ea sede quæ tangitur, contrahitur, sulcusque profundus nascitur, et rugæ ; cibisque aliquando propellitur ut à sede contracta fugiat. Minus tamen quàm intestina ventriculus irritabilis est : hinc emetica fortiora necesse est purgantibus.” — Haller.

the fluids into more general contact with the absorbing surface, and to give greater activity probably to the absorption by the lacteals. I am inclined to think that the stomach is the most irritable part of the body, and susceptible of the most minute distinctions in the nature of the stimuli applied to it. The phenomena of the living animal, and experiments in those recently killed, sufficiently prove the contractile powers of the two orifices. Experiments have been made which shew the powers both of the cardiac and of the pyloric orifices in retaining the contents of the stomach after the œsophagus and duodenum have been cut across. The stomach of a rabbit has been squeezed in the hand after cutting the duodenum, without any of its contents having escaped\*; and in similar experiments, the finger being introduced into the lower orifice of the stomach of an animal yet warm, the fibres of the pylorus were found to contract strongly upon it. Upon forcibly compressing the stomach, the food will be made to pass into the œsophagus much more readily than into the duodenum; which is another proof how necessary the natural series of actions is to the relaxation of the pylorus.

OF VOMITING.—When there is an unusual or unnatural irritation on the stomach, or when it is violently stimulated or opposed in its natural course of action, the motion becomes inverted; and drawing by sympathy other muscles to its aid, the contents of the stomach are evacuated by vomiting. Thus where the food takes changes inconsistent with healthy digestion; or when

\* See a paper in the 3d vol. of Sandifort, *Theſ.*

solid matters lodge in the stomach ; or when secretions of the duodenum pass into the stomach, or unusual actions are propagated backwards upon the stomach from the upper portion of the canal ; or when emetics are taken, which are unusual stimuli ; or when there is inflammation in the stomach, which, from giving greater sensibility, produces the same effect with more violent stimuli ; or when the coats are corroded or ulcerated ;—vomiting is produced. That vomiting may be produced by the inverted motion of the stomach and œsophagus alone, is apparent from experiments upon living animals, where the abdominal muscles are laid open, and from cases in which the stomach has lain in the thorax, and yet been excited to active vomiting\*. Again, it is equally evident that, when the stomach is excited to vomiting, there is consent of the abdominal muscles, by which they are brought into violent and spasmodic action ; not alternating in their action, as in the motion of respiration, but acting synchronously, so as greatly to assist in compressing the stomach : but at the same time, the action of these muscles, however forcible their contraction, cannot alone cause vomiting ; nor has this action any tendency to produce such an effect on other occasions in which the utmost contraction of the diaphragm and abdominal muscles is required to the compression of the viscera. Many have conceived that vomiting is entirely the effect of the action of the abdominal muscles and diaphragm. Such, for example, has been the opinion not only of J. Hunter, but of

\* See Wepfer de Cienia Aquatica, p. 68.—Sauvage's Vomitus.

Duverney,

Duverney, and of M. Chirac in *Hist. de l'Acad. des Sciences*, 1700. M. Littre opposed this notion, and contended before the Academy, that the contraction of the diaphragm was the principal cause of vomiting. M. Lieutaud in 1752 supported the idea that vomiting is the effect of the action of the stomach. He found, upon dissection, in a patient whose stomach had resisted every kind of emetic, that it was greatly distended and become insensible; and concluded that the want of action in the stomach, and consequent loss of the power of vomiting, was a strong proof of the action being the effect of the contraction of the stomach only. There are other more curious instances of disease of the stomach preventing the muscular contraction in any violent degree, and consequently the absence of the usual symptom of vomiting:—an instance of this kind will be seen in Dr. Stark's work. In my Museum, Surgeons' Square, there is a preparation of a stomach, in which the walls had become so thick that they could no longer suffer contraction by the muscular fibres; the consequence of which was that, although the inner coat of the stomach was in a raw and ulcerated state, there was no active vomiting.

The singultus seems the partial exertion of the sympathy betwixt the upper orifice of the stomach and the diaphragm, by which a kind of weak spasmodic action is excited in it, but without a concomitant inverted action in the stomach and œsophagus. It is a convulsive and sonorous inspiration, owing to an irritation of the upper orifice of the stomach and œsophagus, but not exactly of that kind which causes inversion of the natu-



ral actions of the stomach. Thus we have the hoquet des gloutons, the singultus, from some medicines and poisons, from some crude aliment, or even from some foreign body sticking low in the œsophagus, or from inflammation. The bourborigmi and rumination seem to be gentler inverted actions of the upper orifice of the stomach and œsophagus, unassisted by any great degree of compression of the stomach by the abdominal muscles and diaphragm.

The full action of vomiting is preceded by inspiration, which seems a provision against the violent excitement of the glottis, and the danger of suffocation from the acrid matter of the stomach entering the wind-pipe; for by this means the expiration and convulsive cough accompanying or immediately following the action of vomiting, frees the larynx from the ejected matter of the stomach. But the action of the diaphragm is farther useful by acting upon the mediastinum, which embraces the œsophagus, and no doubt supports it in this violent action.

#### NERVOUS OR VASCULAR COAT OF THE STOMACH.

WHAT Haller calls the nervous coat, is the cellular structure in which the vessels and nerves of the stomach ramify and divide into that degree of minuteness which prepares them for passing into the innermost or villous coat. It may with equal propriety be called the nervous, the vascular, or the great cellular coat \*. Taking it

\* To call it cellular coat, however, would be to confound it with the three cellular coats generally enumerated by authors.

as the third distinct coat of the stomach, it is connected with the muscular coat by the SECOND CELLULAR coat, and with the villous coat by the THIRD CELLULAR coat. Strictly, however, it is the same cellular membrane, taking here a looser texture to allow of the free interchange and ramification of vessels. When macerated, it swells and becomes like fine cotton, but has firmer and aponeurotic-like filaments intersecting it, and it can be blown up so as to demonstrate its cellular structure\*. It is in this coat that anatomists have found small glandular bodies lodged, especially towards the extremities or orifices of the stomach.

**VILLOUS COAT.**—This is the inner coat, in which the vessels are finally distributed and organized to their particular end. It is of greater extent than the outer coats of the stomach; which necessarily throws it into folds or plicæ. These folds take, in different animals, a variety of forms: but they are simple in man; from the œsophagus they are continued in a stellated form upon the orifice, but form no valve here. In the body of the stomach they are more irregular, sometimes retiform, and sometimes they form circles or squares, but they have generally a tendency to the longitudinal direction. In the pyloric orifice the villous coat forms a ring, called the valve of the pylorus, which, however, has no resemblance to a valve in its form or action. This ring is not formed by the inner coat of the stomach alone, but by the inner stratum of fibres of the muscular coat, the vascular and cellular coats, and

\* Winslow, sect. viii. p. 64.

the inner or villous coat. The effect of all these coats, reflected inward at the lower orifice, is to form a tumid and pretty thick ring, which appears like a perforated circular membrane when the stomach has been inflated and dried; but in neither state is its direction oblique so as to act as a valve. It seems capable of resisting the egress of the food from the stomach, or the return of the matter from the duodenum, merely by the action of the circular fibres which are included in it.

On the surface of the inner coat of the stomach, small retiform rugæ and a pile of innumerable villi are observed. But this structure of the stomach has not been so fully examined, and is not so perfectly understood as the analogous appearance in the intestines. Glands are also described as opening upon the inner surface of the stomach: and those who have not been able to see these glands, which are seated in the third cellular coat, yet believe in their existence from analogy; while others observe foramina toward the upper and lower orifice of the stomach, which they suppose to be the opening or ducts of glands. These, however, which I believe to be merely cryptæ or follicles, are themselves the secreting surface, and not the ducts of the proper round glandular bodies; at the same time it must be admitted that dissection, as if magnifying and giving size to the structure of the stomach, shews a glandular and tuberculated structure.

**GASTRIC FLUID.** There is secreted into the stomach a fluid, which is the chief agent in digestion. The most common opinion is that it flows from the  
extreme

extreme arteries of the villous coat in general, partly from the mucous cryptæ and ducts \*. When pure, it is a pellucid, mucilaginous liquor, a little salt and brackish to the taste like most other secretions, and having the power of retarding putrefaction and dissolving the food. It acts on those substances which are nutritious to the animal, and which are peculiarly adapted to its habits. It has, consequently, some variety of properties in different animals. The secreting powers of the stomach seem so far to accommodate themselves to the food received into it, that the property of the gastric fluid is altered according to the nature of the food. This affords another argument in favour of a simple diet; since, in a variety of condiments received promiscuously into the stomach, the chance is the greater of some ingredient becoming an offensive load.

It seems to be a peculiarity in the human stomach, that it has a greater capacity for digesting a variety of animal and vegetable bodies. But I should at the same time conceive that the natural power of digesting the simple and appropriate food is diminished as the stomach gains the power of dissolving a variety of substances. In other creatures, a sudden change of food is rejected, and the powers of the stomach are found incapable of acting duly on the aliment, though time so far accommodates the gastric fluid to the ingesta that the animalization becomes perfect. Mr. Hunter speaks of the power of

\* But I should consider these glands rather as analogous to the mucous follicles of the œsophagus and lower portion of the intestine, and merely as lubricating and defending the passages.

cattle eating and digesting their secundines\*. I have known a cow die from this; the membranes being found coiled up within the bowels. But the fact is sufficiently ascertained, that the nature of the digestive process may be so far altered that gramenivorous animals may be made to eat flesh, and carnivorous animals brought to live upon vegetables. This fact throws us back from the simple idea which we should be apt to entertain of the nature of the change produced by digestion, viz. that it is simply chemical. For we see that the nature of the solvent thrown out from the stomach, and its chemical properties, may be changed by an alteration in the action of the coats of the stomach. Thus we are baffled in our inquiries, and brought back to the consideration of this living property, which can so accommodate itself to the nature of the aliment.

The gastric fluid has been collected from the stomachs of animals after death, by sponges which the animal has been made to swallow, or which have been thrust down into its stomach, incased in perforated tubes. And, lastly, it has been obtained by exciting the animal to vomiting, when the stomach was empty; for the secretions of the stomach are then poured out unmixed with food†. Although by these means a fluid may be obtained which may properly be called the succus gastricus, yet it must contain a mixture of the saliva, and secretions from the glands of the œsophagus and pharynx, with the glandular secretions of the stomach, and the general vascular secretion from

\* See Observations on Digestion.

† By Spallanzani.

the surface of the stomach. It is a fluid, then, upon which the chemist can operate with no hope of a successful or uniform result. And indeed chemistry seems no farther to assist us in forming an accurate conception of the changes induced upon the fluids in the alimentary canal, than that the more perfect, but still very deficient, experience of the modern chemist successfully combats the speculations of the chemists of former ages. For example; it was formerly supposed that digestion was a fermentation, and that this fermentation was communicated and propagated by the gastric juice. It is now found that the gastric juice has properties the reverse of this; that it prevents the food from taking an acid or putrefactive fermentation; that it acts by corroding and dissolving the bodies received into the stomach; and that it is itself at the same time converted into a new fluid, distinct in its properties\*. It is almost superfluous to observe, that the gastric juice has no power of acting upon the coats of the stomach during life; whether this be owing to the property, in the living fibre, of resistance to the action of the fluid, or that there is a secretion bedewing the sur-

\* The most curious fact is that property of the coats of the stomach, or of the fluids lodging in the coats of the stomach, by which milk and the serum of the blood are coagulated. It has been found that a piece of the stomach will coagulate six or seven thousand times its own weight of milk. This action seems a necessary preparation for digestion, which shews us that the most perfect and simply nutritious fluid is yet improper, without undergoing a change, to be received into the system of vessels. For example; milk and the white of eggs are first coagulated, and then pass through the process of digestion. See J. Hunter, *Animal Economy*, Observations on Digestion.

face,

face, which prevents the action, it is not easy to say ; but more probably it is owing to the resistance to its action inherent in a living part.

OF DIGESTION. By trituration and mastication, and the union of the saliva with food in the mouth, it is merely prepared for the more ready action of the stomach upon it. No farther change is induced upon it than the division of its parts and the forming of a soft pulp. But in the stomach, the first of those changes (probably the material one) is performed, which by a succession of actions fits the nutritious matter for being received into the circulation of the fluids of the living body, and for becoming a component part of the animal. For now the gastric juice acting on this fluid mass quickly dissolves the digestible part, and entering into union with it produces a new fluid, which has been called chyme. The mass has changed its sensible and chemical properties ; it has suffered the full action of the stomach, and by the gradual and successive muscular action of the stomach it is sent into the duodenum. The contents of the stomach consist of air (partly swallowed, partly extricated by chemical change, but still more in all probability by the heat) ; of chyme ; and of a grosser part incapable of becoming nutritious, and the separation of which from the chyme is accomplished by the action of the canal. Now the stomach being stimulated by fulness, by flatulency, and more still by the peculiar irritation of the food to which it is natural to suppose its sensibility is adapted, the muscular coat is brought into action, and the contents of the stomach delivered into the duodenum. Here having additional ingredients, it is farther changed

changed in its nature, and approximates more to that of the fluids circulating in the vessels. It is called chyle; it has become a white milky fluid, which by the property of the living surface of the villous coat is separated from the mass, and absorbed by the lacteal vessels of the intestines\*.

**HUNGER AND THIRST.** We are solicited to take food by the uneasy sensation of hunger, and by the anticipation of the voluptuous sating of the appetite, and by the pleasures of the palate. Hunger is considered as the effect of the attrition of the sensible coats of the stomach upon each other by the peristaltic motion of the stomach and compression of the viscera. This appears to be too mechanical an explanation. If the sensation proceeded merely from such attrition of the coats of the stomach, food received into the stomach would be more likely to aggravate than to assuage the gnawing of hunger; to excite the action of the stomach would be to excite the appetite, and an irritable stomach would be attended with a voracious desire of food. Something more than mere emptiness is required to produce hunger. There appears to be a deficiency of the due stimulus to the stomach, and a consequent uneasy sensation which is allayed by fulness. Hunger does not appear to be occasioned by stimulus, but by a want of due excitement, by which the irritability of the coats and action of the vessels are as it were suffered to accumulate; and this tension, and irritation, and fulness of vessels, is relieved by the food,

\* See farther of the lacteal and absorbent system.

which



which excites the action, draws out the fluids, and gives activity to the system of vessels.

THIRST is seated in the tongue, fauces, œsophagus, and stomach. It depends on the state of the secretions which bedew these parts, and arises either from a deficiency of secretion or from an unusually acrid state of it. It would appear to be placed as a monitor calling for the dilution of the fluids by drink, when they have been exhausted by the fatigue of the body and by perspiration, or when the contents of the stomach require a more fluid state,—the more easily to suffer the necessary changes of digestion.

The cardiac orifice is the chief seat of all sensations of the stomach both natural and unusual, as it is the most sensible part of the stomach. Indeed we might presume this much by turning to the description and plates of the nerves; for we shall find that this upper part of the stomach is provided in a peculiar manner with nerves, the branches of the par vagum.

The sympathy of the stomach with the rest of the intestinal canal, the connection of the head and stomach in their affections, the effect of the disorder of the stomach on the action of the vascular system and of the skin, and the strict consent and dependence betwixt the stomach and diaphragm and lungs, and in a particular manner with the womb, testicle, &c.—and again, the connection of the stomach with the animal œconomy, as a whole,—must not escape the attention of the student of medicine.

## SECTION III.

## OF THE SMALL INTESTINES.

THE small intestines are described as that part of the intestinal canal which is betwixt the pyloric orifice of the stomach and the valve of the colon. They are reckoned in length at four or five times the height of the body: they form that part of the canal in which the digestion is completed, and the nutritious fluids absorbed from the waste of the ingesta. They are commonly subdivided into the duodenum, jejunum, and ileon; or more simply into the duodenum and intestinum tenue\*.

## OF THE DUODENUM.

THE DUODENUM stands distinguished from the general tract of the small intestines by its shape, connections, and situation. It is greatly larger than any other part of the small intestines; irregularly circular; more fleshy; and, although it has fewer plicæ, it is more glandular and more vascular: but its greatest peculiarity, and that which must convince us of its importance in the animal œconomy, and of the necessity of attending to it in disease, is this, that it is the part which receives the biliary and pancreatic ducts, and in which a kind of second stage of digestion takes place; and that by the disorder of these secretions it must be primarily affected. The duodenum takes a course across the

\* Haller.

spine from the orifice of the stomach until it touches the gall-bladder. First it goes in a direction downward; then it passes upward till it touches the gall-bladder; then making a sudden turn it descends directly near to the right kidney, and is then involved in the lamina of the mesocolon; it then takes a sweep towards the ~~right~~ side, obliquely across the spine, and a little downward; it afterwards runs behind the head of the pancreas and the great vessels passing to the small intestines betwixt the vena cava and the vena portæ; and then again toward the left of the aorta, but still bound down by the root of the mesocolon\*. This portion of the intestine receives its name from being usually measured off twelve fingers breadth, or from five to six inches, from the orifice of the stomach. I have always preferred, however, a natural and not an arbitrary division, and have considered that portion of the intestines as duodenum, which is above the lower lamina of the mesocolon, or the point at which it emerges from the stricture of the mesocolon. As in this extent, besides being tied down to the spine by the mesocolon, it has the peritoneum reflected off from it at other points, we have to remark the ligamentum duodeni renale, ligamentum duodeni hepaticum.

Although we shall presently treat of the coats of the small intestines in general, yet it may not be improper here to observe what are announced as peculiarities in

\* How comes it then, seeing the acute turns of this intestine, that Ruysch calls it "Intestinum digitale, vel intestinum rectum brevissimum?" *Adversar. Anat. Decad. II.*

See a good description of the duodenum by M. Laurent Bonazzoli, in the Transactions of the Academy of Bologna.

the

The coats of this first division. The first or peritoneal coat is imperfect, as must already be understood: for it does not invest the whole circumference of the gut; it ties it down more closely, or it merely contains it in its duplicature, while a greater profusion of cellular membrane accompanies this than the other divisions of the intestines. The muscular coat is stronger than that of the jejunum and ileon; the plies formed by the inner coats, smaller than those of the other part of the small intestine, and having more of a glandular structure. At the lower part of the first incurvation of the duodenum, the inner coat forms a particular process like to those which are called *valvulæ conniventes*; and in this will be discovered the opening of the biliary duct, within which also the *ductus pancreaticus* generally opens.

It is not without some reason that anatomists have considered the duodenum as a second stomach, calling it *ventriculus secundus*, and *succenturiatus*; for there is here performed a change upon the food, converting the chyme, (as they have chosen to call it,) which is formed in the stomach, into perfect CHYLE. But to suppose that the chyme is perfected in the duodenum, is to suppose the biliary and pancreatic secretions necessary to the formation of chyle; a point which is not allowed: for many suppose that the bile is merely a stimulus to the intestines, holding a controul over their motions; others, that it is useful only in separating the chyle from the excrement; or again, that the bile is decomposed, part entering into the composition of the chyle, while the other goes into that of the *feces*: it seems to bestow upon them a power of sti-

mulating the intestinal canal in a greater degree; and as the chyle is formed occasionally without the presence of bile, we may be induced the more readily to allow that the bile does not in the natural actions and relations of the systems enter into the composition of the chyle. At all events, we see that it is the bile which is the peculiar stimulus of the intestinal canal, and that when interrupted in its discharge from the ducts, the motions of the belly are slow, and costiveness is the consequence.

We see, then, that at all events there are poured into the duodenum from the liver and pancreas, secretions which have an extensive effect on the system of the viscera; and we must acknowledge that the derangement of these secretions must operate as a very frequent and powerful cause of uneasiness, and that the duodenum must often be the seat of disease and distressing symptoms. We may observe that, from the course of the duodenum, pain in it should be felt under the seventh or eighth rib, passing deep, seeming to be in the seat of the gall-bladder, and stretching towards the right hypochondrium, and to the kidney, and again appearing as if on the loins. We may observe farther, that from the connections of this portion of the intestine, and from the manner in which it is braced down by the mesocolon, spasm, when flatus is contained in it, will sometimes produce racking pains. Nay farther, when the irregularities of digestion affect the duodenum, and spasm and distention follow; the distention causes it to press upon the gall-bladder, and the pressure and the excitement together cause an irregular and often an immoderate flow of bile, which with the  
acrid

acid state of the food produces anxieties and increased pain, inverted motion, vomiting, and even cholera \*.

We must not forget, that the inverted action of the stomach draws quickly after it the inverted motion of the duodenum. It may be of consequence to attend to this in the operation of an emetic, for the stomach will sometimes appear to be discharging foul and bilious matter which we naturally may suppose to have been lodged in it, but which has actually flowed from the duodenum, or has even come recently from the ducts in consequence of the operation of the vomit †.

From a defect in the natural degree of the stimulating power of the bile, it will accumulate in the duodenum, occasioning anxiety and loss of appetite, and even congestion of blood and a jaundiced skin; we may certainly affirm that these at least are often connected. Such accumulation in the duodenum must be attended with a languid action of the whole canal, and inactivity of the abdominal viscera, because the peristaltic motion is begun here in the natural action of the intestines; and if its peculiar stimulus be deficient, so must that of the whole system of the viscera. Hence the necessity of rousing and evacuating the whole canal.

I may farther observe, that it has been the opinion of the most respectable old physicians, those whose

\* Indeed vomiting in consequence of concussion and compression upon the whole contents of the abdomen, and in a particular manner on the liver, affords most powerful means of operating upon the infarction and remora of the blood in the hepatic system.

† See Sandifort, vol. iii. p. 288. See Hoffman.

knowledge of diseases has been drawn from an acquaintance with anatomy, from the frequent inspection of dead bodies, and the observation of the symptoms during life, that the study of the diseases connected with the duodenum is the most important which can occupy the attention of the medical enquirer.

#### OF THE SMALL INTESTINES IN GENERAL.

The small intestines, under the name of jejunum and ileon, occupy the space in the middle and lower part of the abdomen, the great mass forming convolutions in the umbilical region. The cylindrical canal of the small intestines is gradually and imperceptibly diminished in diameter as it is removed from the lower orifice of the stomach; so that the termination of the ilion in the caput coli is considerably smaller than the duodenum. This tract of the small intestines performs the most important function of the chylipoëtic viscera (if any can be said to be peculiarly important where the whole is so strictly connected); for here the food is moved slowly onward through a length of intestine more than four times the length of the body\*, and exposed to a surface amazingly extended by the pendulous and loose duplicatures of the inner coat. Here the fæces are gradually separated from the chyle, and the chyle adhering to the villi is absorbed and carried into the system of vessels.

\* The whole length of the intestinal canal is generally estimated at from six to seven times the length of the whole body.

The

The JEJUNUM \* is the upper portion of the small intestine. Its extent is two-fifths of the whole. Its convolutions are formed in the umbilical region.

The ILEON lies in the epigastric and ileac regions, surrounds the jejunum on the sides and lower part, and forms three-fifths of the whole extent of the intestine from the mesocolon to the valve of the colon. The coats of the ileon are generally described as thinner and paler; the valvular projections of the inner coat less conspicuous; and the mucous glands are apparent in the lower portion. The several parts however of this, which we may call the long intestine †, do not preserve a very exact relation in regard to their place in the belly, but in their motions they may be drawn to the right or left, upward or downward. This however I am convinced takes place in a much less degree than is generally believed.

There is sometimes found a lusus in the lower part of the ileon before it passes into the colon; a blind pouch or cæcum is, as it were, attached to the ilion resembling the caput coli. I have found this in one

\* So named from its being more generally empty. Indeed the higher parts of the canal can never be distended, because the contents pass slowly and gradually and with little interruption through them; but they are in a manner accumulated below.

† We may then speak of the small intestines in general, meaning the whole tract from the stomach to the great intestine; the duodenum being the space betwixt the stomach and the lower lamina of the mesocolon, the long intestine being the tract extending from the duodenum to the colon.



instance only. Sometimes there is more than one in the course of the ileon \*.

#### MINUTE STRUCTURE OF THE SMALL INTESTINES.

We have in some measure anticipated the general enumeration and character of the coats of the intestines, by what has been said upon the coats of the stomach; for we have here to distinguish the four great coats, the peritoneal, the muscular, the vascular, and villous coats.

#### THE PERITONEAL COAT AND MESENTERY.

The peritoneal coat of the small intestines is of the same nature with that of the stomach, liver, spleen, &c. It is a thin, smooth, pellucid membrane. On the surface it has a moisture exuding from its pores; and it firmly adheres to the muscular fibres beneath. Its transparency makes the muscular fibres, blood-vessels, and lymphatics easily distinguishable; and when it is dissected or torn up, the longitudinal muscular fibres will be found in general attached to it. Its use is to give a smooth surface and strengthen the intestine, and in a great measure to limit the degree of this distention.

\* The appendices cæcales of the ileon have given birth to a curious question in the pathology of hernia. See "*Hernia ab ilii diverticulo.*" Morgagni, Adv. Anat. III. "*Hernie formée par l'appendice de l'ileon.*" LITTRE, Mem. de l'Acad. Royale des Sciences, an 1700; Ruyfch, Palfin, &c. See cases of anus at the groin in the Museum, Surgeons' Square.

The peritoneal coat of the intestine is continued and reflected off upon the vessels and nerves which take their course to the intestine: or, what is the same thing, and indeed is the more common description, the two lamina of the peritoneum which form the mesentery, after proceeding from the spine and including the vessels, nerves, and glands belonging to the tract of the intestine, invest the cylinder of the intestine under the name of peritoneal coat\*. The mesentery is composed of membranes, glands, fat, and the several systems of vessels, arteries, veins, lacteals, and nerves. As in reality it is a production of the peritoneum, it may be said to arise from the mesocolon, or the mesocolon from the mesentery, reciprocally. But at present we may trace the mesentery from the root of the mesocolon;—for the jejunum, emerging from under the embrace of the mesocolon, carries forward the peritoneum with it; and the laminæ of the peritoneum, meeting behind the gut, include the vessels which pass to it and form the mesentery. This connection of the small intestines by means of the prolongation of the peritoneum, while it allows a considerable latitude of motion, preserves the convolutions in their relations, and prevents them from being twisted or involved. But it is by the walls of the abdomen that the intestines as well as the more solid viscera are supported; for when the bowels escape by a wound, a portion of an intestine will hang down upon the thigh, unrestrained by the connection with the mesentery.

\* See Plate I. 5. 6. 7. 8. ♡

The mesentery begins at the last turn of the duodenum, or beginning of the jejunum. Its root runs obliquely from left to right across the spine. Here it has no great extent; but as it is prolonged toward the intestines, it spreads like a fan, so that its utmost margin is of very great extent; which may be conceived when we consider that it is attached to the whole extent of the small intestines. In the middle of the small intestine, the mesentery has its greatest extent or breadth; towards the beginning of the duodenum and the termination of the ilion, it is shorter, and more closely binds down the intestine.

#### MUSCULAR COAT OF THE INTESTINES.

There is not a more important point of consideration in the anatomy of the viscera, than this of the action of the muscular coat. The appearance and course of the fibres shall first be described, then their action, and lastly their effect in disease.

The peritoneum is united to the muscular coat by a very delicate and dense cellular membrane; which in the enumeration of the coats we must call the first cellular coat, but which really does not deserve the name of a distinct coat; for, as already said, the outer lamina of the muscular coat is raised with the peritoneum, and adheres intimately to it. The fibres of the muscular coat of the intestines are simpler than those of the stomach; for here there are only two sets of fibres, the longitudinal and circular fibres. The outer stratum consists of the very minute and delicate longi-

tudinal fibres. Indeed, when the system has been exhausted by a long and debilitating illness with scarcely any excitement of the intestinal canal, these fibres are not to be observed. In a man who has been cut suddenly off by disease, or who has died a violent death, they become more demonstrable; and in diseases where there has been congestion and excited action in the intestines, they are of course still stronger and more discernible. The internal stratum of the muscular fibres is much stronger and more easily demonstrated. These fibres will be observed much stronger about the duodenum and upper part of the jejunum, but they become weaker and more pellucid towards the extremity of the ileon. Tracing any particular fibre of the circular stratum, it is found to form only a segment of a circle, a part of the circuit of the intestine. It seems lost amongst neighbouring fibres or cellular connections; but still, taken together, the circular muscular fibres uniformly surround the whole gut\*.

To account for that action of the intestines which urges on the food, we may suppose a greater degree of irritability and activity to reside in the upper portion, where of course is commenced that action which is successively propagated downward, carrying the *fæces* into the lower part of the canal. Some anatomists have ingeniously imagined that the inner stratum of fibres surrounds the intestine not in a circular direction, as was asserted by Willis, but obliquely and in a spiral course; from which followed a simple explanation of

\* Morgagni *Adversaria Anatomica* III. ♣ *Animadversio* V.

their

their effect, since the contraction of the fibre winding lower in the intestine pursued the contents with a uniform progressive constriction.

Physiologists have made a distinction in the motion which they have observed in the intestines of living animals. The one they call the vermicular, and the other the peristaltic motion. Upon looking into the belly of a living animal, or of one newly killed, there may be observed a motion among the intestines, a drawing-in of one part and a distention and elongation of another part of the convolution. This motion has some resemblance to the creeping undulating motion of a reptile, and has got the name of vermicular motion. On the other hand, the direct contraction of the gut by the constriction of the circular fibres is the peristaltic motion. We must not however allow ourselves, from the loose expression of authors, to imagine, that these circular straight fibres act separately: on the contrary, excited by the same stimulus, they have a simultaneous motion to the effect of accomplishing the perfect contraction of the gut and motion of its contents \*.

While the stimulus is natural, the contraction of the muscular coat is in a regular series from above downward, and, the lower part contracting before the upper is completely relaxed, the food must be urged downward into the lower portion. I should even imagine that the lower portion is relaxed, from its more usual

\* Neither can I allow that the acting of the longitudinal fibres in one portion of an intestine dilates that which is below, otherwise than by the compression of food and flatus.

degree

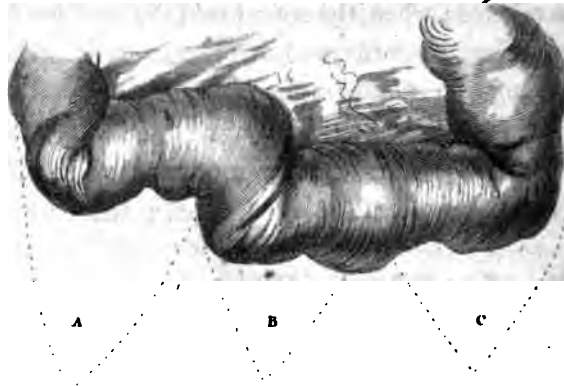
degree of tension, or slighter permanent degree of action\*.

#### ANTIPERISTALTIC MOTION.

When the successive contraction of the muscular fibres of the intestines is opposed in its natural course downward, either by a violent stimulus (the effect of which is to cause a more permanent contraction in the coats, and one which does not readily yield to the relaxation that follows, as in the natural contraction), or when there is a mechanical and obstinate interruption to the contents of the bowels; then is the natural action reversed. This antiperistaltic motion must arise thus; a portion of the intestine being constricted, and not yielding to the contraction which in the natural action of the gut should follow in order, the motion of the gut must be stationary for a time, until the part above is again relaxed; when, the contents of the intestine finding a free passage upwards, and that portion contracting and propelling the matter still upwards and retrograde, (since it is opposed by the contraction below,) a series of retrograde or antiperistaltic motions are produced. The course of the action is changed; the contraction

\* From the experiment of Haller and of others, it is proved that the irritability of the intestines long survives that of the heart: that the intestines are in general in lively motion, when no motion can be observed in the stomach: but that sometimes the motion of the stomach continues longer than that of the intestines. It is proved also that the action of the intestine is adequate to the motion downward and the discharge of feces, without the aid of the abdominal muscles. See *Mem. par Haller sur les Mouvemens des Intestins.*

of the gut is not followed by the dilatation of the part below, but by that of the part above. By this means the matter of the lower portion of the intestinal canal is carried into the upper part, and there acting as an unusual stimulus it aggravates and perpetuates the unnatural action. Nay, from experiments it appears that a permanent irritation will cause an accelerated motion in both directions, that from the point stimulated there will proceed downward the regular series of contractions and dilatations, while the motion is sent upwards and retrograde from the same point of the intestine toward the stomach\*. And this observation, the exhibition of medicine and the diseases of the intestines confirm. But farther we may observe, that the food is not uniformly moved downward; it is shifted and agitated by an occasional retrograde motion thus:



The portion of the intestine included under A contracts and sends its contents into B. B contracting sends its fluid contents in part backward into A, but

\* Haller, loc. cit., Exper. 424.

in

in a greater proportion into C. While the contents of the middle portion are sent into the lower part in a greater proportion than into the higher division, the tendency of the food will be in its natural course, downward; whilst at the same time it suffers an alternate motion backward and forward; so that it is more extensively applied to the absorbing surface of the intestines.

The stimulus to the intestines is matter applied to their inner coat; and although there is much sympathy in the whole canal, yet unless there be matter within a portion of the canal, that particular part has little action. Accordingly, when there is obstruction to the course of the aliment, by whatever cause it may be produced, the portion below becomes shrunk and pale, and free from the effects of inflammation; while that stimulated by the food, being in a high state of excitement, irritated by the presence of matter which it is unable to send forward, evacuated only partially by an unnatural and highly excited retrograde action, it becomes large, thick in its coats, strong in its muscular fibres, and greatly inflamed, till it terminate at last in gangrene\*.

The unusual excitement of the muscular fibres produces a very curious effect in the intus-susceptio, or the

\* Huguonot gives an experiment illustrating the cause of ileus. He tied a ligature about the intestine of a cat, and found no antiperistaltic motion excited. This is not wonderful; it is the excitement arising from matter within the gut, to which there is no exit, and not the stricture of it, which is the cause of the violent symptoms.—A case in the Museum will give the young student a correct judgment on this subject.



slipping of one portion of the gut within another. This may be done by applying acrid matter to the intestines of living animals; and I have no doubt that it has been produced by giving purges too strong and stimulating in cases of obstruction of the bowels. By the contractions of the muscular coat greatly excited, the intestine is not only diminished in diameter so as to resemble an earth-worm \*, but in length also. This great contraction of the outer coats accumulates the vascular and villous coat as if into a heap; which from the compression of the muscular coat is forced into the neighbouring relaxed portion. This first step leads only to a succession of actions; for the fibres of the relaxed or uncontracted part, sensible to the presence of this accumulated and turgid villous coat, contracts in succession so as to draw a part of the contracted gut within the relaxed portion. If the irritation is done away or ceases quickly, as in the experiments on animals, another turn of the intestine coming into play distends this, and undoes the intus-susceptio. But if the cause continues, the intus-susceptio is continued; the included part of the gut is farther forced into the other. By these means the vessels going to the included part are interrupted; the villous coat swells more and more; and several feet of the upper portion of the intestine is often in this way swallowed down. It is not however in the natural course downward that this preternatural action always proceeds; for, as the excitement is violent and unlike the usual stimulus of

\* See Haller's Experiments; and "Dissections of the Atrophica Abactatorum;" with plates; by Dr. Cheyne.

food,

food, and as we know that an unusual excitement is very apt to cause an inverted action, it often happens that the intussusception is formed by the lower portion of the gut included in the upper part.

#### VASCULAR COAT.

This third coat of the intestines, or what is commonly called the nervous coat, is a stratum of cellular membrane in which the vessels of the gut are distributed. It might with equal propriety be called the cellular coat; and is indeed what some anatomists have called the third cellular coat. By inverting the gut and blowing strongly into it, the peritoneal coat cracks and allows the air to escape into this coat; which then swells out, demonstrating its structure to be completely cellular\*. Its use evidently is to suffer the arteries, veins, and lymphatics to be distributed to such a degree of minuteness as to prepare them for reflection into the last and innermost coat, and for entering into the structure of the villi: for they come to the extremity of the mesentery as considerable branches, but forming in this coat a uniform texture of vessels, their extreme branches are finally distributed to the inner coat. This is the coat in which, in some parts of the intestines, little glands or cryptæ are lodged.

\* An experiment, to which Albinus attaches much importance. See also, in the Acad. de Bologna, a paper by Mr. D. G. Galeati on the fleshy coat of the stomach and intestines.

## VILLOUS COAT.

The most curious part of the structure of the intestines is the villous or inner coat; for by its organization is the chyle separated from the general mass of matter in the bowels, and carried into the system of vessels. To this all we have been describing is merely subservient.

The villous coat has a soft fleecy surface; and being of greater extent than the other and more outward coats, it is thrown into circular plaits which hang into the intestine, taking a valvular form. They have the name of *VALVULÆ CONNIVENTES*. Some of them go quite round the inside of the intestine; others only in part. They are of larger or smaller extent in different parts of the canal: for example; they begin a very little way from the lower orifice of the stomach irregularly, and tending to the longitudinal direction; further down they become broader, more numerous, and nearly parallel; they are of greater length, and more frequent in the lower part of the duodenum and upper part of the jejunum. These valvular projections have their edges quite loose and floating in the canal; and from this it is evident that they can have no valvular action. Their use is to increase the surface exposed to the aliment; to enlarge the absorbing surface; and at the same time to give to it such an irregularity that the chyle may lodge in it and be detained\*. Into

\* “*Superficies internæ hujus tunicæ ad mensuram geometricam, aliquoties integumentorum communium superficiem amplitudine superat.*” *Sœmmering, vol. vi. p. 295.*

the structure of these plicæ of the villous coat, the vascular or cellular coat enters, and generally in the duplicature a small artereal and venous trunk will be observed to run. That these plicæ are formed chiefly by the laxity of the connection and the greater relative extent of the inner coat, is apparent upon inverting the gut, and insinuating a blow-pipe under it, for then you may distend the cellular substance of the vascular coat so as entirely to do away the *valvulæ conniventes*.

The pile or lanuginous surface from which this coat has its name, is to be seen only by a very narrow inspection, or with the magnifying glass. It is owing to innumerable small filaments which project from the surface, like hairs at first view, but of a flat or rounded figure as the state of fulness and excitement or depletion shows them. They consist (as appears by the microscope) of an artery and vein, and lacteal or absorbing vessels, and to these we may surely add the extremity of the nerve. They have a cellular structure; they are exquisitely sensible; and, when stimulated by the presence of fluids in the intestines, are erected, and absorb the chyle. They are the extremities of the lacteal absorbing system, and their structure would seem to be subservient to the absorption by the mouth of the lacteal vessel \*.

But the surface of this coat is not only an absorbing one, it also pours out a secretion: and indeed it is as a

\* See further of their structure under the title of the **LACTEAL** and **LYMPHATIC SYSTEM**, in this volume, where the subject of absorption and the structure of the villi is treated.

secreting surface, upon which medicines can act, that it is to us one of the most powerful means of acting upon the system in disease. The fluid which is supplied by the surface of the intestines is called the liquor entericus; a watery and semipellucid fluid, resembling the gastric fluid. This fluid, physiologists have affected to distinguish from the mucous secretion of the glands of the inner surface of the intestines; but it is impossible to procure them separate\*.

## GLANDS.

Anatomists have observed small mucous glands seated in the cellular membrane of the intestines†, the ducts of which they describe as opening on the villous surface of the intestines. They are seen as little opaque spots, when the intestine is cut in its length and held betwixt the eye and the light. They have been chiefly observed in the duodenum; few of them in the general tract of the small intestines. Little collections or agmina are observed, which increase in frequency to-

\* It has been supposed that the fluids excreted from the surface of the intestines were furnished by very minute foramina (which are visible by particular preparation) in the interstices of the villi. See the letter of Malpighi to the Royal Society of London on the Pores of the Stomach; and the paper by M. Galeati in the Bologna transactions on the Inner Coat, which he calls the Cribiform Coat. These pores, according to Galeati, are visible through the whole tract of the canal, and particularly in the great intestines.

† Peyrus. Biblio. Manget. Brunnerus de glandulis duodeni. Wipfer, Morgagni, &c. These he supposed additional pancreatic glands.

ward the extremity of the ileon. It is natural to suppose that as the contents of the intestines become in their descent more acrid and stimulating, there will be a more copious secretion of mucus in the lower intestines for the defence of the villous coat.

## SECTION IV.

## OF THE GREAT INTESTINES.

THE great intestines form that part of the intestinal canal which is betwixt the extremity of the ileon and the anus. They differ essentially from the small intestines in their size, form, and general character; and in the texture, or at least in the thickness of their coats.

The great intestine, beginning on the right side of the belly, rises before the kidney; passes across the upper part of the belly, under the liver, and before or under the stomach\*. Then making a sudden angle from under the stomach and spleen†, it descends into the left ileac region. Here, making a remarkable turn and convolution, it descends into the pelvis by a curve running in the hollow of the sacrum.

The great intestines are accounted to be about seven feet in length, and to bear a relation to the small intestines as five to twenty-five.

\* This turn of the colon from the right across the belly is *flexura prima, superior dextra hepatica* Soemmering.

† *Flexura secunda, superior sinistra lienalis.*

The natural division of this portion of the intestine is into the cœcum, colon, and rectum \*.

#### VALVULA COLI.

The extremity of the intestinum ileon enters as it were into the side of the great intestine at an angle †. And here there is a valvular apparatus formed by the inner membrane of the gut, which, more than any other circumstance, marks the distinction betwixt the small and great intestines; for as the effect of this valve is to prevent the regurgitation of the fæces into the small intestines, it marks sufficiently the nature of the change produced on the ingesta in their passage through the small intestine, and how unfit in their acrid and putrescent state they are to be longer allowed lodgment there.

Upon opening the caput coli, or lower part of the colon, on the right side, and examining the opening of the ileon into it, we see a slit formed betwixt two soft tumid plicæ of the inner membrane of the gut; the one of these is superior; the other inferior. They are soft, and moveable, and seem scarcely calculated for a valvular action. But there is little doubt that when the great gut is distended or in action, they are calculated to resist the retrograde passage of the fæces

\* Some authors divide the great intestine into six parts, enumerating the cœcum; pars vermiformis; the right; the left; and the transverse colon; and the last part or rectum.

† Of the entering of the small intestine into the greater, see Morgagni Adversar. iii. Animad. xi.

into

into the ileon. In the oblong opening of the ileon, and in the broadness of the valvular membranes, there is considerable variety. The superior valve is transverse, smaller and narrower than the lower one; the lower one is longer, and takes a more extensive curve: and sometimes the lower one is so remarkably larger than the upper valve, that it gives a great degree of obliquity to the insertion of the ileon into the colon, so as to approach to that structure which we see in the entrance of ducts, as the biliary duct into the intestine, or the ureter into the bladder. At the extremities of these valves they coalesce and run into the common transverse folds of the colon: and this is what Morgagni has called the *fræna*. At this place of union of the ilion and colon the longitudinal muscular fibres of the ilion are mingled and confounded with the circular fibres of the colon\*. The circular muscular fibres certainly enter so far into the composition of the valve, that they embrace the margin, and, by contracting during life, must make the experiments on the action of this valve in the dead body less decisive than they would be were we certain that this valve acts on principles strictly mechanical.

The discovery of the valve of the colon, and which, from its action in guarding the ileon, might rather be called the valve of the ileon, has been claimed or attributed to many anatomists, chiefly to Varolius, Bauhin, and Tulpius; and it sometimes receives the name of the two later anatomists.

\* Winflow.



## CÆCUM.

We have seen that the ileon is inserted into the side of the colon: now that portion of the gut which is below this union of the ileon is a round or slightly conical sac, from two to three inches in length. It is attached by cellular membrane to the iliacus internus muscle. It is not a regular sac, but is divided into large cells like those in the rest of the colon, and has considerable varieties in different subjects.

## PROCESSUS, SEU APPENDIX VERMIFORMIS.

There is appended to the cæcum a small gut, also blind; but bearing no relation in size or in figure to any part of the intestinal canal. This gut, from its smallness and twisted appearance, like the writhing of an earthworm, has received the name of vermiformis. It is somewhat wider at the connection with the great intestine, and stands off obliquely, so that sometimes its inner membrane takes the form of a valve\*. It scarcely ever is found containing fæces, but only a mucus excreted from its glands. In the foetus the appendix vermiformis is comparatively much larger, its base wider; upon the whole, more conical, and containing meconium; and in the young child it often contains læces.

\* Morgagni. M. Laur. Bonazzoli in the Acad. of Bologna.

## GREAT DIVISIONS OF THE COLON.

The great divisions of the colon (which I conceive it necessary to enumerate, chiefly with a view to the accurate description of the seat of disease) are these: First, the RIGHT DIVISION of the COLON rises from the insertion of the ileon, and from that part of the great intestine which is tied down by the peritoneum and cellular membrane, and ascends on the right side of the small intestines, until it gets under the margin of the liver, and in contact with the gall-bladder. Of course, this part will be found to take some considerable varieties in its form, depending upon its state of distention.

## THE TRANSVERSE COLON\*.

The transverse colon is that part of the great intestine which often takes a course directly across the belly, but which generally forms an arch before or immediately under the stomach. When this part of the colon however is much distended, being at the same time held down by the mesocolon, its angular turns reach under the umbilicus, nay even to the pelvis. For the varieties in the situation of this intestine and the viscera in general, see Morgagni Adversar. Anat. ii. Animadver. ii.

The LEFT OR DESCENDING COLON is short: for between the point, where the colon begins to bend down on the left side, and those violent turns which

\* COLON TRANSVERSUM. ZONA COLI.

it takes before terminating in the rectum, is but a short space. It is here attached to the diaphragm and psoas muscle.

The SEGMOID FLEXURE of the colon \* is formed by a narrowing and contraction, and closer adhesion of the gut to the loins below the left kidney, and to the cup of the ileum by the peritoneum, which seems to have the effect of throwing it into some sudden convolutions. The colon then terminates in the rectum.

#### PECULIARITIES IN THE COLON DISTINGUISHING IT FROM THE SMALL INTESTINES.

The coats of the great intestines are the same in number and in structure with those of the small intestines; but they are thinner and more difficult to be separated by dissection. The villi of the inner coat are smaller; the mucous glands or follicles are sometimes very distinct; and, lastly, the muscular fibres have some peculiarities in their arrangement. The most characteristic distinction in the general appearance of the great and small intestines, is the notched and cellular appearance of the former. The cells of the colon, being formed betwixt the ligamentous-like stripes which run in the length of the gut, have a regular three-fold order. These cells give lodgment to the *fæces*; retain the matter; and prevent its rapid descent or motion to the rectum. Here the fluids are still more exhausted, and the *fæces* take often the form of these cells. When the great intestines are torpid, and inert

\* From its resembling the Roman S.

in their motions, the fæces remain too long in the cells of the colon, and become hard balls or scibulæ. But when in this state of costiveness the intestines are excited by medicine, not only is the peristaltic motion of the intestines increased, but the vessels pour out their secretions, loosening and dissolving the scibulæ\*.

## MUSCULAR COAT.

The ligamentous-like bands of the colon form three fasciculi running in the length of the gut: one of these, obscured by the adhesion of the omentum, is not seen without dissection; and the other is concealed by the mesocolon †. These bands are formed by the longitudinal fibres of the gut, being concentrated into fasciculi, and not uniformly spread over the general surface, as in the small intestines: and being at the same time more firmly connected with the peritoneal coat, they give the appearance outwardly of ligament more than of muscular fibres ‡. The inner or circular muscular fibres of the great intestines are like those of the small intestines, uniformly spread over their surface, and are stronger than those of the latter.

**FÆCES.** That the food digested, in part absorbed, and its fluids exhausted, becomes fæces in its progress through the intestines, will be universally allowed:

\* See note of the pores of the intestines.

† Stratum liberum, stratum omentale & tertium Mesocolicum. Soemmer, § ccxxx.

‡ See Morgagni. See also Galeati on the fleshy coat of the stomach and intestines, in the Memoirs of the Acad. of Bologna.

but

but how much of the excrementitious matter in the colon is a human secretion is not equally attended to. Men who have died of want, and men exhausted by long fever or other distress, and who did not or were incapable of taking nourishment, have had discharges of *fæces*; and *fæces* are found in their intestines upon dissection. The *foetus* has the intestines filled with *mæconium* \*. The effect of a purge is not only to stimulate the intestines to throw off their contents, but the inner secreting surfaces pour out their fluids. The surface of the intestines is not only calculated to absorb nourishment, and capable of throwing off the fluids from the system, like the kidneys in secreting the urine, but it seems destined in a particular manner to carry off the earthy parts of the body, which in the circle of actions is alternately undergoing renovation and decay. Thus the *fæces* consist of the food and chyme, which has not been converted into chyle and absorbed, but which has been decomposed, and has entered into new combinations; it is united to part of the bile, which has also been decomposed; to the secretion of the pancreas; to the secretion of the immense extent of surface of the intestines; and many substances are found in the excrements which did not exist in the food. From the same sources (*viz.* the secretions poured into the intestinal canal, or directly from its surface) are formed concretions, often of an enormous size; often distinct from the nature of the more common biliary secretions †; and sometimes these earthy

\* See Haller *Phil. Elem.* tom. vii. sect. 6. § 3.

† Haller *loc. cit.*

deposits

deposits entering into the composition of the *fæces*, give to them a stoney hardness.

#### RECTUM.

The RECTUM forms the last division of the great intestines; and I know no better proof of the impracticability of altering the names in anatomy than this, that anatomists have, in almost every age, insisted on the impropriety of calling this gut, which answers in its shape to the curve of the sacrum, a straight gut; and yet always, and to the present day, it is rectum.

From the last turns of the colon, called sigmoid, the gut is continued over the promontory of the last vertebra and sacrum (a little to the left side), and falls into the pelvis. It runs down, in a curved direction, betwixt the sacrum and bladder of urine. In the upper part it is covered by the peritoneum, and has its fatty appendages like the colon, but less regular; and sometimes the fat merely deposited under the peritoneal coat. It is tied down by the peritoneum, in form of meso-rectum; but, deeper in the pelvis, it loses the peritoneum (which, as we have said, is reflected up upon the back of the bladder, and forms here lateral folds), and the rectum is connected with the lower part of the bladder and vesiculæ seminalis by cellular membrane. In women, the muscular fibres of the rectum and vagina are intimately connected\*.

\* Winslow.

The muscular coat of the rectum is particularly strong. The fleshy bands of the colon, spreading out, are continued down upon the rectum in an uniform sheath of external longitudinal fibres. The circular fibres of this part of the gut are also particularly strong; and towards the extremity, appearing in still stronger fasciculi, they obtain the name of sphincter, of which three are enumerated: and this, to distinguish it from the others, is called the intestinal or orbicular sphincter.

The internal coat of the rectum does not deserve the name of villous, nor of papillaris. Its surface is smooth, and there are often distinctly seen little foramina like the mouths of ducts or follicles, in part the source of the mucous discharge, which is sometimes poured out from this gut. Towards the anus the fold becomes longitudinal, and terminates in the notched-like irregularities of the margin.

## C H A P. III.

OF THE SOLID OR GLANDULAR VISCERA OF  
THE ABDOMEN.

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SECTION I.  
OF THE LIVER.

OF ITS SEAT, AND CONNECTIONS BY LIGAMENTS,  
AND OF THE DIVISIONS APPARENT ON ITS SUR-  
FACE.

**O**UR attention is now naturally drawn to the liver, as it holds, in so eminent a degree, the sovereignty over the motions of the intestinal canal, and as it is so strictly connected with it by its system of vessels, and by its functions. The liver is the largest viscus in the body, and as in its size and proportion to the whole body it is great, so are its connections in other respects with the whole system very intimate. This is particularly evident in the diseases of the liver, and was the cause of the ancients ascribing to it so eminent a place in the œconomy.

**FUNCTION OF THE LIVER.**—In all ages authors have paid particular attention to the liver, and have exercised their ingenuity in giving various explanations  
of



of its function. The ancients made it the supreme director of the animal system. They supposed that they could trace the nutritious fluids of the intestines through the meseraic veins into the porta and into the liver, and that it was there concocted into blood. From the liver to the right side of the heart they found the cava hepatica, carrying this blood formed in the liver to the centre of the system: and through the veins they supposed the blood to be carried to the remote part of the body.

The liver is the largest glandular body of the whole system. Its use is to secrete the bile, which is carried into the intestines, and performs there an essential action on the food while passing in the tract of the intestines.

SEAT OF THE LIVER.—The liver is seated in the upper part of the abdomen, under the margin of the ribs, and towards the right side, or in the right hypochondrium. In the foetus it occupies more of the left side than it does in the adult. Indeed it is nearly equally balanced in the foetus, but the older the animal (or at least for the five first years) the greater will be the proportion of it found lodged in the right side.

Without going into the more minute subdivisions of this viscus, we may observe, that it is more uniform, and smooth, and convex on the upper surface; on the lower, more irregularly concave. Its upper surface is applied in close contact to the concavity of the diaphragm, and in the foetus its margin is in contact with the abdominal muscles, because it falls lower than the margin of the ribs. Its lower and concave surface receives the convexity of the stomach, duodenum, and colon. In a healthy

healthy adult subject the liver does not extend from under the margin of the ribs, unless near the pit of the stomach, but in the foetus and child it is much otherwise. In a foetus of the third and fourth month the liver almost fills the belly; it reaches to the navel, covers the stomach, and is in contact with the spleen. After the seventh month other parts grow with a greater rapidity in proportion. Indeed some have affirmed, that the liver, or at least the left lobe, actually decreases towards the time of birth\*. But from this time to the advance to manhood the chest becomes deeper; the sternum is prolonged; and the diaphragm becomes more concave; so that the liver retires under the margin of the ribs, and its margin on the left side in the adult reaches no farther than to the œsophagus. When however the liver becomes schirrous and enlarged, its hard margin comes down so as to be felt through the abdominal parietes under the border of the chest. This enlargement of the liver, and consequent descent of its margin, is to be felt more easily by grasping the integuments of the belly, as if you expected to lift up the acute edge of the liver, than by pressing with the point of the finger. By this means we shall be sensible of the elasticity and softness below the liver, and of the resistance and firmness of the margin of it. The physician, however, should not forget, that the depression of the diaphragm, and consequent protrusion of the liver by disease in the thorax, gives the feeling of an enlargement and hardening of the liver. The left great division of the liver is perhaps as

\* M. Portal. Acad. de Sciences, 1773.

often diseased and enlarged as the right, in which case it is more difficult to ascertain it by examination, and it must be learnt from other circumstances besides the actual touch.

Neither should a physician be ignorant, that by supuration in the lungs, and consequent rising of the diaphragm, the liver is elevated considerably, so as to retire farther under the protection of the false ribs\*.

M. Portal, by running stilettos into the belly of the subject as it lay upon the table, or was raised into the perpendicular posture, found that in the latter posture the liver shifted two inches. But it is almost superfluous to remark concerning these experiments, that they are by no means conclusive. In the dead body, the abdominal muscles are relaxed; they yield to the weight of the viscera; and the diaphragm is pulled down by the weight of the abdominal viscera. The margin of the liver necessarily falls lower, but in the living body there is a close and perfect bracing of every part by the abdominal muscles; they do not yield, and very little if any alteration can take place in the situation of the viscera.

It must be observed, however, that a considerable motion of the liver is the effect of respiration, and of the action of the diaphragm. This motion is chiefly on the back part of the right lobe of the liver. The left lobe being more on the centre of the belly, and consequently opposite to the centre and less moveable part of the diaphragm, it is less affected by the respiration than the larger right lobe.

\* These observations in detail belong to another place.

## LIGAMENTS OF THE LIVER.

The peritoneum is reflected in such a manner from the neighbouring parts upon the liver as to form membranes receiving the name of ligaments. It has been explained, however, that these are not the sole support of this viscus; and that the compression of the surrounding abdominal muscles is the principal support of the liver, as it is of the other viscera.

The **BROAD LIGAMENT\*** of the liver is formed by two lamina of the peritoneum, connected by their cellular membrane, descending from the middle of the diaphragm and point of the sternum to the convex upper surface or dorsum† of the liver. This ligament is broadest where it passes down from the point of the sternum to the fossa umbilicalis; but as it retreats backward it becomes narrower, and is united to the coronary ligament near the passage of the vena cava. This circumstance, with the curve which it naturally takes on the surface of the liver, gives it the shape of the falx, as it is formed by the dura mater.

**LIGAMENTUM TERES.** The round ligament of the liver is the firmer ligamentous-like cord, which may be traced from the umbilicus along the peritoneum into the duplication of the broad ligament, and into the fossa umbilicalis. It is formed by the degenerated coats of the great vein which brings the florid blood from the placenta into the veins of the liver, and from

\* Ligamentum latum suspensorium, falciforme.

† See Plate I. of this volume.

thence conveys it into the right side of the heart of the foetus\*.

THE CORONARY ligament of the liver is formed in consequence of the attachment of the liver to the diaphragm. The attachment is of course surrounded by the inflection of the peritoncum from the diaphragm to the liver. It is called the coronary ligament, though it has been observed, that this attachment of the liver is not circular, but of an oval, and very oblong shape. It appears, that it is this close adhesion of the liver to the diaphragm, which is the occasion of the sympathy of the diaphragm in disease of the liver, and the cause of the pain felt in the shoulder and neck from inflammation, and suppuration in the liver, in consequence of the course and connections of the phrenic nerve.

The LATERAL LIGAMENTS are formed by the peritoneum continued laterally. The right lateral ligament, like a mesentry, attaches the right and great lobe of the liver to the diaphragm, and the left lateral ligament connects the left lobe with the diaphragm, and with the œsophagus and spleen.

#### FORM AND DIVISIONS OF THE LIVER.

The liver is convex and smooth on the upper surface; concave and more irregular on the lower part; thick and massy behind and towards the right side; but anteriorly and toward the left side it is thin, and has an acute edge, so that it lies smooth over the distended stomach.

\* See vol. ii. p. 171. and Plate, p. 173.

**GREAT RIGHT AND LEFT LOBES OF THE LIVER.—**

The first great division of the liver is marked on the convex surface by the broad ligament ; which running back from the fossa umbilicalis divides it into the two great lobes, the right and left. When the concave surface of the liver is turned up, we see the same division into the right and left lobes by a fissure which runs backwards.

It is on this lower surface of the liver that we have to mark the greater variety of divisions in this viscus. Farther, it is on the right lobe that those eminences are to be observed, which, with the indentations and fulci, give some intricacy to this subject.

**LOBULUS SPIGELII \*.**—The lobulus spigellii is betwixt the two greater lobes, but rather belonging to the right great lobe. From its situation deep behind, and from its having a particular papilla-like projection, it is called lobulus posterior, or papillatus. To the left side it has the fissure for the lodgment of the ductus venosus ; on the right, the fissure for the vena cava ; and above, it has the great transverse fissure of the liver for the lodgment of the cylinder of the porta : obliquely to the right, and upwards, it has a connection with the lower concave surface of the great lobe by the processus caudatus, which Winslow calls one of the roots of the lobulus spigellii. It is received into the bosom of the lesser curve of the stomach.

**LOBULUS CAUDATUS †.**—This really deserves the name of processus caudatus, for it is like a process of

\* *Lobulus posterior—posticus—papillatus.*

† *Processus caudatus.*

the liver, stretching downward from the middle of the great right lobe to the lobulus spigellii. It is behind the gall-bladder, and betwixt the fossa venæ portarum and the fissure for the lodgment of the vena cava.

LOBULUS ANONYMUS \* is the anterior point of the great right lobe of the liver: or others define it to be that space of the great lobe betwixt the fossa for the umbilical vein and the gall-bladder, and extending forward from the fossa for the lodgment of the porta, to the anterior margin of the liver.

SULCI, AND DEPRESSIONS OF THE LIVER.—On the lower surface of the right lobe there may be observed two slight excavations, formed as it were by the pressure of the colon and of the kidney. On the lower surface of the left lobe there may also be observed depressions answering to the convexities of the stomach and colon. But these are only the slighter irregularities which might pass unnoticed. There are, besides these, deep divisions which pass betwixt the lobes and lobuli, and indeed form these eminences.

UMBILICAL FISSURE †.—From the anterior point of the two lobes there passes backwards to the left side of the lobulus spigellii a deep fissure, which in the fœtus gives lodgment to the umbilical vein, and which in the adult receives the round ligament, where it is about to terminate in the left division of the vena portæ. The back part of this fissure gives lodgment to the ductus venosus in the fœtus. This fissure divides the liver into its two right and left divisions, and upon the right side joins the transverse fissure.

\* Lobulus accessorius—anterior—quadratus.

† Horizontal fissure, fossa longitudinalis, longa anterior.

THE TRANSVERSE FISSURE is that which passes above the lobulus spigelii, and lobulus quadratus; the processus caudatus, and the lobulus lobi sinistri. It is in this fissure that the great transverse division of the vena portæ lies.

THE POSTERIOR FISSURE \* gives lodgment to the ductus venosus. It is a division in the posterior margin of the liver betwixt the left lobe, and the lobulus spigelii, and great lobe on the right. Sometimes, instead of the fissure or sulcus, there is a canal, as it were, in the substance of the liver.

The fourth great fissure, is that for the lodgment of the vena cava. It sometimes is called, in contradistinction to the last, the right fissure, or the FISSURA VENÆ CAVÆ. It is a large deep division betwixt the lobulus spigelii and the back part of the right lobe, for receiving the vena cava as it passes up upon the spine.

The gall-bladder being sunk in the substance of the liver, the pit or excavation which receives it has been considered improperly as a fissure or fossa †. There likewise occur irregular fissures in the substance of the liver, which are like the cuts of the knife, and hold no regular place.

#### OF THE VESSELS OF THE LIVER, AND OF THE CIRCULATION OF THE BLOOD THROUGH IT.

There belong to the liver five distinct systems of vessels: these are, the vena portæ; the arteria hepati-

\* Or sulcus ductus venosi, the left fissure.

† It is generally called, *fovea fellis*, or *vallicula vesiculae felleæ*.



ca; the vena cava hepaticæ; the lymphatics; and the biliary ducts\*. These, with the nerves, form a very intricate system of vessels, but a lesson of the most particular importance to the physician. Before speaking of the connections which these vessels constitute with particular parts, or with the entire system, we shall take a strictly anatomical view of their origin and course.

#### THE VENA PORTÆ.

This vein is divided into two parts; that which belongs to the intestines, and which, ramifying on the mesentery, receives the blood of the mesenteric arteries; and that part which branches in the liver, and distributes there the blood which it has received from the arteries of the membranous viscera. Even from this division we see that the vena portæ has a very particular distribution; that while it is collecting its branches from the spleen, stomach, and intestines, like the veins in the other parts of the body, into a trunk, this trunk, instead of leading directly to the heart, or uniting with other veins in their course to the heart, enters the liver, and, like an artery, spreads into minute ramifications; hence it is called the vena arteriosa. It resembles an artery in this also, that it has no valves like other veins.

To be more particular; the vena portæ takes its origin from the extreme branches of the cœliac, upper

\* And we might add, the arteries of the outer membrane of the liver which arise from the internal mammary, phrenic, epigastric, and even the spermatic arteries.

and

and lower mesenteric arteries. The roots of the portæ answering to these arteries are the splenic vein; the gastro-epiploic vein which runs upon the great arch of the stomach; the mesenteric vein returning from the small intestines; and the right and middle colic veins, and internal hæmorrhoidal vein and left colic returning upon the mesocolon. These answering to the three great branches of the abdominal aorta, pass obliquely upward in three great divisions, and unite with some lesser veins, as the coronary and smaller veins of the stomach, and pancreatico-duodenalis. The trunk of the vena portæ is now involved in the irregularly reticulated web of the hepatic vessels, arteries, veins, glands, lymphatics, nerves, and biliary ducts, with their cellular membrane. It passes upward somewhat obliquely to the right; and enters the PORTA\* or the sinus betwixt the processus caudatus and lobulus spigelii.

When the vena portæ has entered the liver, it divides into two great branches, which running directly transverse, and being of large capacity, are sometimes called the cylinder of the vena portæ. Of these two great branches of the vena portæ within the liver, the right is greater in diameter, but shorter †: it ramifies in the great right lobe of the liver. The left is longer considerably, and filling the transverse fissure it is reflected up into the umbilical or horizontal fissure, and is given to the left lobe, to the upper and more anterior

\* Sometimes it has been found divided before entering the liver. It has been also found to divide into three branches, in which cases, says Haller, two go to the left side.

† Into this branch sometimes the vein of the gall bladder enters.

part of the right lobe, viz. lobulus anonymus, and to the lobulus spigelii.

The minute ramifications of the vena portæ every where pervade the substance of the liver, and inosculate with the veins of the surface belonging to the peritoneal coat. The blood of the vena portæ, after secreting the bile, is received into the extremities of the venæ cavæ hepaticæ.

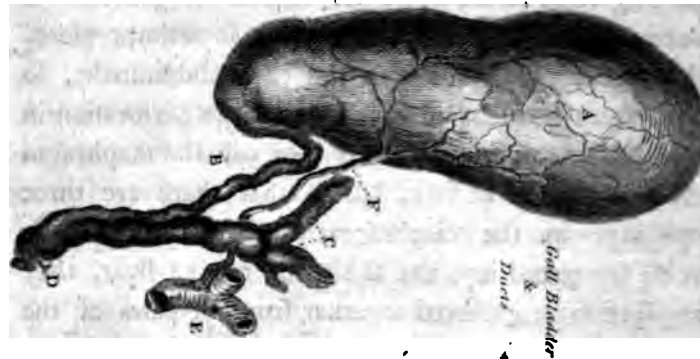
#### ARTERIA HEPATICA.

For the course of this artery from the root of the cœliac artery, to its entrance into the liver, see vol. ii. p. 416. and 419. The arteria hepatica and the venæ portæ are supported by the same sheath, the lesser vessel encircling the greater, like a tendril. While they have distinct functions, both terminate in the same returning veins: that is to say, whether we admit that one or both open into the biliary ducts, yet they have the same relation to the venæ cavæ hepaticæ which the arteries of the other parts of the body have to their returning veins.

#### VENÆ CAVÆ HEPATICÆ.

We have seen, that the right auricle of the heart is close to the diaphragm above, and that the liver adheres to the lower surface of the diaphragm. We have also found that there was a groove in the back part of the liver for the transmission of the venæ cavæ abdominalis. Now as the venæ cavæ ascending from the lower parts of the body to the heart is perforating

the diaphragm, it is joined by two large veins from the liver, which, from their size and form, being the returning veins of the liver, are termed in general the *venæ cavæ hepaticæ*. These veins sometimes pierce the diaphragm alongst with the *cavæ abdominalis*, so that there is to be observed one large perforation in the diaphragm, but generally they pass the diaphragm close to the great vein, but so that there are three openings in the diaphragm. When these hepatic veins are traced into the substance of the liver, they are seen to be gathered together from all parts of the liver in two, or sometimes three great branches. The communication betwixt the *vena portæ* and the *venæ cavæ hepaticæ* are so free, that several anatomists have imagined a peculiar and more immediate communication of their branches than holds in other parts of the body betwixt the arteries and veins; a circumstance which appeared to them the more necessary, considering the lesser impetus with which the blood flows in the *vena portæ* than in the arterial system.



#### BILIARY DUCTS\*.

The last subdivision of the substance of the liver, or acini, as we shall presently find, is supplied with a branch of the *venæ portæ*, *arteria hepatica*, and *venæ hepaticæ*. With these there is also seen a minute ramification of the excretory duct of the liver. These last minute branches are the roots of the biliary duct; which running into each other form trunks resembling the branches of veins, and which attaching themselves to the *vena portæ* form the greater trunks, answering

\* *Explanation of the plate of the gall-bladder.*

- A The gall bladder.
- B The cystic duct.
- C The hepatic duct.
- D The common duct.
- E The hepatic artery.
- F The cystic artery coming off from it.

to the right and left side of the liver. These two divisions of the hepatic duct approaching each other, unite (C), while they are attached to the right branch of the vena portæ. Their union constitutes the hepatic duct, or ductus choledochus.

When the duct of the liver has advanced a little way from the transverse fissure, it is joined by the cystic duct (B), or perhaps we should rather say, considering the use of the cystic duct, that it is reflected from it at an acute angle to the right side. The ductus cysticus is much smaller than the hepatic duct; and is somewhat curved in the direction towards its expansion into the gall-bladder; for there it takes a very sudden turn downward, as is seen in the marginal plate.

The hepatic duct, after being joined by the cystic duct, continues its course under the name of ductus communis choledochus, or common duct\*. Now become somewhat larger, it takes its course under the head of the pancreas to the back part of the duodenum, about five inches from the pylorus.

Before it enters the gut, or more generally while included in the coats, it is joined by the pancreatic duct. Having pierced the muscular coat, it runs for some time in the cellular coat, in the length of the gut, and then opens upon the eminence of a considerable valvular plica of the inner coat.

This hole is regularly limited, and by no means equal to the diameter of the duct, either where it is contained within the coats of the gut, or in its course.

\* Ductus choledochus, hepatico cysticus, (D.)

from

from the liver to the gut. Sometimes the hepatic and pancreatic duct open by distinct perforations.

The outer coat of these ducts is smooth and strong \*; within this a cellular and nervous coat is described †, and muscular fibres imagined; but the inner coat is worthy of attention. It is reticulated in such a way, that a probe pushed up the duct is caught by their valve-like action ‡.

#### GALL-BLADDER.

We have already noticed, that the gall-bladder is attached to the lower surface of the right lobe of the liver, and partly buried in its sinus: it has sometimes occurred that it was merely suspended to the liver by a membrane like a mesentery. It is a bag of a pyriform shape; its greater end or fundus is contiguous to the colon; its lower end or neck to the duodenum. It has been found wanting altogether §. It is generally of a size to contain an ounce, or an ounce and a half of bile.

\* Although this coat resists, in a considerable degree, the distention of the duct, when blown into or injected, yet the whole are sometimes so distended as to admit the thumb. But this is rather to be considered as growth and enlargement, than distention.

† By Haller.

‡ These I have seen mistaken for actual obstructions.

§ In which case the dilated ducts in their course would seem to have been capable of retaining a quantity of bile ready to be evacuated into the intestine. A double gall bladder has sometimes been found.

The

The coats of the gall-bladder are the outer peritoneal coat \*; a middle cellular coat, what from its analogy to that of the intestines we should call vascular coat; and an inner coat. In the intermediate coat muscular fibres have been looked for with great eagerness, but none have been demonstrated, although a conviction remains that there are muscular fibres in the composition of the coats of the gall-bladder. This coat gives form, limit, and strength to the gall-bladder. The third or inner coat is formed into innumerable rugæ, so as to take a cellular or reticulated texture. These loculi, as we may call them, thus formed by the duplicature of the internal membrane, are of considerable variety of shape, square, round, or triangular. These rugæ, and the whole internal membrane of the gall-bladder, have a beautiful and minute net-work of vessels upon them; and in these cells there can be little doubt that there are small mucous follicles, or pores, or an exudation from extreme vessels, whose discharge sheaths the surface from the irritation of the acrid bile. The extreme degree of vascularity and reticulated texture of this inner coat of the gall-bladder is not apparent before the sixth or seventh month of the fœtus, and then it takes a peculiar texture in preparation for the reception of the secreted bile.

\* Like the peritoneal coat of the liver, it seems to possess very distinct vessels from the vascular coat below. " Si itaque ea, a reliquis membranis solvitur expletis antea materia quadam colorata vasis, ab arteria hepatica et vena portarum venientibus; videmus eam ne minimum quidem accipere furculum quo ornantur nervæ et vasculosa." Annotationes Acad. F. Aug. Walter, p. 57.

Towards



Towards the opening of the bladder into the cystic duct the rugæ take a semilunar figure, and seem to have a valvular action, in at least so far that they seem intended to give a degree of difficulty to the passage of the bile. The same structure of the internal coat prevails in the cystic duct.

However strange it may appear to one, considering the relation of the liver as a gland to its ducts, and to the gall-bladder as a receptacle of the bile, an opinion was entertained that the bile of the gall-bladder was secreted by its own coats, and that it was of a different nature from the bile conveyed from the substance of the liver. Without further argument it is sufficient to say, that when the cystic duct is tied, or when it is preternaturally obstructed, there is no bile secreted into the gall-bladder \*.

From the connections of the gall-bladder, and from the consideration of the whole anatomy, there can remain no doubt that the gall-bladder is a mere receptacle, reserving a sufficient store of this fluid for the due change to be performed upon the food: that as the stomach is not at all times loaded with food, nor the chyme and fluid from the stomach incessantly passing through the duodenum, neither is the bile at all times running from the gall-ducts. On the contrary, as the stomach is emptied of its contents at

\* Were there no other proof of the gall-bladder being merely a receptacle, and not in any degree for secreting the bile, the course of its veins (which run into the vena portæ) would be sufficient indication. If they had returned the blood from having performed the secretion of the bile, they would have dropt into the cava, and not into the portæ.

stated

— stated intervals, there seems to be a provision for a quantity of bile being evacuated from the receptacle and ducts proportioned to the food, and while it is passing the duodenum. Whether we should conceive that this is a necessary consequence of the retention of the bile in the gall-bladder, or a wise provision of nature, I am uncertain; but it appears, that the longer the bile is retained, or the longer the fast and the deficiency of food in the duodenum, the more acrid and inspissated is the bile, and the greater also in quantity. This inspissation of the bile takes place in consequence of the activity of the lymphatics, which ramifying on the coats absorb the thinner part of the bile.

Further; I cannot look upon the rugæ and cellular structure of the inner coat of the gall-bladder in any other light than as the means of increasing the surface, and exposing the bile to a further absorption of its watery parts than otherwise would take place.

The gall-bladder is supposed by some to be emptied by the general pressure of the abdomen; an opinion founded on a mistake, which a very little consideration might correct. Others think that the stomach, or duodenum, or colon, being distended by the food, compress and empty the gall-bladder; while others with more apparent correctness allege, that it is emptied in consequence of a consent of parts. With the latter I would confidently affirm, that as the aliment passes the duodenum, the bile follows apace, either from the alternate contraction and relaxation of the duodenum occasioning a relaxation of the orifice of the ducts, or more probably from the ducts being excited, as the salivary glands are excited by the presence of sapid

bodies in the mouth. By want and hunger, on the contrary, the gall-bladder is allowed to distend : there is no call for its evacuation.

Experiments would even teach us, that the gall-bladder has not the same irritability excitable by stimuli applied to the coats, as the stomach, intestines, or bladder of urine ; which is a proof that, like the iris, and many other parts of the body, its action is roused more powerfully by the stimulus of sympathy and consent of remote parts, than by the distention of its coats ; whereas the intestines and bladder have it in their constitution to be excited to contraction by simple distention.

From experiments it would appear, in confirmation of what is here alleged, that while the food is in the stomach little bile is discharged ; but that it flows when the matter is passing the duodenum, so that a great quantity is then formed in the gut. On the contrary, in a state of want and hunger, the gall-bladder is greatly distended, and yet little bile flows from it ; although it is not only more accumulated, but more acrid and bitter \*.

The gall-bladder is not destitute, however, of irritability and the power of contraction ; for it would appear from many cases that, like the urinary bladder, it contracts upon concretions, and becomes thick in its coats.

The retention of the bile, surcharging the ducts, and distending the gall-bladder, and the sudden discharge of accumulated bile, and the irregularities of

\* Anat. generale de Xav Bichatton. iv. p. 6. 5.

its course when influenced by disorder of the viscera, are the source of the most severe and distressing symptoms\*.

In the dead body we see the colon and duodenum, or whatever parts lie in contact with the gall-bladder, stained with bile; but this evidence of transfusion which is found in the dead body, is not seen in the living; while the stain from the bile is observed to be deeper and more extensive in bodies long dead. It is therefore another example of the peculiar properties inherent in the living fibres, that no transfusion is allowed; but that the fluids, which appear as if exuding from the living surfaces, are discharges from organic pores, or from the extremities of vessels.

#### OF THE MINUTE STRUCTURE OF THE LIVER.

The liver is firmer and dryer in some degree than any of the other viscera; the intertexture of membrane is weak, and in consequence the substance of the liver is friable and easily torn. When cut or torn, it seems for the greater part vascular; or it displays the mouths of innumerable ducts and vessels, and, after a minute injection, the blood-vessels seem to pervade every particle, even when examined with the microscope.

This texture of vessels, in which we may say the substance of the liver chiefly consists, is surrounded

\* We have one example of this in a late Treatise on the Diseases of the Bowels of Children, by Dr. Cheyne: an essay most particularly useful in its object; and the reasoning of which is founded on anatomical observation, supported by facts, and deductions from practice.

with a delicate membrane, the continued peritoneum. It retains the character of peritoneum, in being a simple membrane, whitish, and a little pellucid. In this membrane minute arteries and veins ramify, which are unconnected with the internal system of vessels, and in the close cellular membrane beneath it the lymphatic vessels take their course.

When a section is made of the liver, the vessels may be thus distinguished: the ducts by the thickness of their coats, and their yellow colour; the arteries by a less degree of thickness, and a more resisting elasticity; the branches of the vena portæ and the cava hepaticæ by the thinness of their coats, of which those of the latter are considerably the weaker.

With the investiture of the peritoneal coat of the liver even the vascular tissue of the body of the liver has no communication by vessels\*. It is therefore considered as an organ of a peculiarly distinct organization. By the proofs from anatomical injections we are informed, that there is a free intercourse through the extreme branches of all the five systems of vessels in the liver. From minute injections, and the trying and making of sections in the liver, there seems no likelihood of gaining information of the structure and connections of these vessels. Walther, who seems to have examined more methodically and minutely than any other anatomist in any age, could make no distinction of parts. In whatever way he made his sections, whatever system of vessels he filled, whether the whole vessels or each separately, he could not ascertain the direction and

\* Soemmering. Walther, loc. cit. &c.

course of any particular vessel, nor its inosculations, but all was obscure, and as if constituting one chaotic mass. In wet preparations, however, he observed, that the extremities of the branches of the hepatic artery opened into the vena portæ: that the branches of the vena portæ had a double termination: that some of them, by a sudden turn and serpentine course, terminated in the branches of the venæ cavæ hepaticæ\*; while others were seen to terminate or open into the biliary ducts. Further he observed, that in all the branches of the vena portæ there was a peculiar compressed appearance which distinguished them from all the other vessels of the viscus.

There have been observed, by almost every author, intersections of the intimate membrane of the liver, which divides and subdivides the fasciculi of vessels. These are, however, obscure divisions. The last perceptible divisions have been called ACINI†; and they are rather presumed than directly proved to have in their composition an extreme ramification of the several vessels of which the liver consists‡.

We have seen Malpighi conceiving that these bodies were simple glands collected on the ramifications of the vessels; that they were little vesicles; and that from

\* I should imagine that in this he might have been deceived by the lesser branches of the portæ (filled with injection) opening into the side of the larger trunks; and that there is no such termination of the hepatic arteries in the sides of the vena portarum, so that their open mouths are discernable.

† See the definition in the introduction to the present volume.

‡ Acinos nemo rejicit, ne Ruyschius quidem, sed de interiori fabrica disputatur. Haller.

them the pori bilarii took their origin. In this opinion he was successfully opposed by Ruysch, who affirmed that these were vascular; and in this he has been supported by Albinus. It would in truth appear, that the description of these partitions of the substance of the liver, and the ultimate subdivision of it unto these little grains, about which there has been so much speculation, is not founded in an accurate observation, and that there are neither criptæ, hollow or cellular, nor little bodies made up of convoluted arteries, but the minute parcels of vessels which are observable may be called acini, in the strict definition which has been given in the introduction.

Finally, Ruysch's opinion may be given in these words: (Epist. ad Virum Clar. Ner. Boerhaave, p. 69.) “Sed nolo diutius tergiversari, fateor ergo, quod, quando primo incipiebam me exercere in anatomicis, videbam tunc quidem, quod in jecore humano se ostendebant acinuli parvi innumerabili numero, quæ tum temporis appellabantur glandulæ; nam nemo cogitabat aliter sed manet sola jam hæc questio, an acinuli hi hic herentes sint glandulæ simplicissimæ, folliculi cavi cum emissario an quid aliquid? dico nemo demonstravit illos tales esse ut hic assumis. Imo vero facile jam erit demonstrare, acinos hos cum criptis antea pertractis nihil commune habere: quia oculis nostris non apparent ut membranulæ cavæ & quia etiam non habent emissarium. Sed componuntur tantum ex extremitatibus ultimis vasculorum sanguiferorum unitis in formam spheræ rotunditatis, neque, quantum possum videre etiam membranula aliqua sua singulari circumambiuntur.”

## OF THE SECRETION OF THE BILE.

Upon reviewing the whole system of the liver the peculiarities in the vena portæ strike us the most. It occurs to us that the passing of this profusion of blood retrograde into the liver, with the slow motion peculiar to venous blood, and after having gone the circulation through the intestines, and consequently lost those properties which constituted it arterial blood, is a provision for the secretion of the bile. It is almost universally concluded, that the secretion of bile is made from the blood of the vena portæ.

But as we see that this blood distributed by the branches of the vena portæ in the liver must be so far exhausted as to become incapable of all the uses accomplished by the arterial blood in other glands, that although the vena portæ be peculiarly adapted to secrete the bile, it is not capable of supplying the nutrition and the energy to the substance and vessels of the liver, there is a necessity for arterial blood being sent to this gland through a branch of the arterial system. We have had occasion to remark, that no part retains its function in vigour, nor the living properties which are inherent in it, while the whole œconomy is entire and correct, unless the blood be circulated through it. Therefore it would appear necessary that the arteria hepatica, a branch of the aortic system, should also be bestowed upon this viscus. These arteries perform the same office here in the liver that the bronchial arteries do in the lungs, or the coronary arteries in the heart,



or the *vasa vasorum* in the great vessels. The pulmonic artery carries venous blood into the lungs, which having returned from the circulation of the body cannot send off smaller branches to supply the membranes and vessels of the lungs, it is necessary that for this purpose branches of the aortic system shall enter the lungs. Again, in the heart the blood contained in its ventricles is incapable of supplying its substance, or the blood coming through the calibre of the great vessels cannot be the means of ministering to their active powers, but for this purpose the *vasa vasorum* are distributed through the coats of the vessels. These vessels therefore bear an analogy to the *arteria hepatica* in the liver.

We must not however suppose that this scheme of the action of the vascular system of the liver, however rational and simple, will be universally allowed. Indeed there are circumstances which seem to stand in opposition to it. Of these, the most interesting is the case of unusual distribution of the vessels of the liver communicated by Mr. Abernethy of St. Bartholomew's hospital.

The subject was a female infant which was supposed to be about ten months old. Among other varieties it was observed, that the branch of the *cœliac* artery distributed to the liver was larger than common, and exceeded by more than one third the usual size of the splenic artery. This was the only vessel which supplied the liver with blood for the purpose of either nutrition or secretion. The *vena portarum* was formed in the usual manner, but terminated in the inferior cava nearly on a line with the renal veins. The liver was

of the usual size, but had not the usual inclination to the right side of the body : it was situated in the middle of the upper part of the abdomen, and nearly an equal portion of the gland extended into either hypochondrium. The gall-bladder lay collapsed in its usual situation. It was of a natural structure, but rather smaller than common. On opening it there was found in it about half a tea spoonful of bile. The bile in colour resembled that of children, being of a deep yellow brown, and tasted like bile, but it was not so acridly bitter and nauseating as common bile.

Mr. Abernethy remarks upon this case, that when an anatomist contemplates the performance of biliary secretion by a vein, a circumstance so contrary to the general œconomy of the body, he naturally concludes that bile cannot be prepared unless from venal blood ; and he also infers, that the equal and undisturbed current of blood in the veins is favourable to the secretion ; but that the circumstances of this case in which bile was secreted by an artery prove the fallacy of this reasoning\*.

We may further observe on this case, that it does not prove the bile in the natural œconomy to be secreted by the arteries and not by the vena portæ ; for the artery here was unusually large, so that it performed a function in this instance which it does not usually perform. On the contrary, had the artery been of the usual size, we might then have concluded that the vena portæ was distributed to the liver to serve some

\* See Mr. Abernethy's case, of uncommon formation of the liver. *Phys. Transactions.*

less use in the œconomy of the system, and that it did not secrete the bile.

The liver, it is said, was of the ordinary size. Now as the bulk of the liver is, in its natural state, made up of the dilated veins, it is some proof of what I should imagine had taken place here, that by some provision of the vessels the arterial blood had been diffused, and the celerity of its motion checked previous to its ultimate distribution. Nay, it may have opened into the branches of veins answering to the extremities of the vena portæ.

In the deficiency of the due acrid and bitter state of the bile, there is in this case evidence that the bile formed from the arterial blood is still unfit for the perfect secretion. I conceive this to be countenanced by the circulation of the blood in the liver of the fœtus, and by its effects upon the secretion. We have seen that almost the entire gland is supplied with arterial blood returning from the umbilical vein; and the natural deduction from this is, that it is the cause of the less stimulating quality of the bile in the fœtus.

I conclude, that this singular and interesting case may strengthen the opinion which some have entertained that the extreme branches of the hepatic artery pour blood into the extremities of the vena portæ previous to this formation of the bile by these veins; but it still leaves us with the general conclusion that the peculiarities in the distribution of the vena portæ are a provision for the secretion of the bile, and that the branch of the aortic system, the hepatic artery, is otherwise necessary to the support of the function of the liver.

Finally,

Finally, as to the use of the liver independently of the secretion of the bile, we must lay aside the opinions mentioned by Haller that it supports the diaphragm, protrudes it up in expiration, and receives the contraction of it equally in inspiration, so as uniformly to compress the other abdominal viscera; or that it foment and cherishes the stomach by the heat of its blood. These are at least as bad as the theories of the ancients mentioned in the beginning of this section. Haller's failing is the promiscuous admittance of all facts and every kind of theory, with a timorousness and indecision in giving his own opinion.

There is another remark of Haller which deserves attention. When I reflect, says he, that there is no bile required in the foetus, there being no food received: when again I see that the liver is of great size in the foetus, and not small like the lungs, which are destined to an operation in the œconomy after birth, I cannot but suspect that it has some other use in the foetus than the secretion of the bile. If the umbilical vein had opened directly into the cava, he thinks it would have returned with too great an impetus upon the heart, and would by its preponderancy have retarded the return of the blood from the lower extremities. He thinks that the liver is useful in breaking and weakening the impulse of the blood from the umbilical vein; that it is a guard to the right auricle, which would be otherwise endangered by the rapid flow of the blood. Now surely the liver is much less able to stand the impulse of the blood than the heart; and yet there is no provision for the breaking of the force of the blood in the liver. Further, there is a direct duct of communication

munication leading to the heart. There is no reason to believe that the umbilical vein carries back the blood with greater force than any other returning vein: on the contrary, from its size and the length of its course it is natural to suppose the motion of the blood in it to be very slow and equable.

We must look upon the peculiarities in the circulation of the blood in the liver of the fœtus as a provision against the secretion of stimulating bile; for when the child is born and the circulation altered, bile is formed more abundantly, and becomes the stimulus to the whole abdominal viscera, rousing them to new action. As to the comparison which Haller has made between the state of the liver and that of the lungs, it is evident that the latter, though small in bulk, are fully formed, and want only inflation to complete their function. On the contrary, in the liver of the fœtus the vessels are necessarily distended with blood, to give them the size requisite for this future function; but that blood, either from its qualities or from the easy and direct passage it has into the heart, does not secrete the bile in quantity and quality so as to stimulate the ducts and intestines, as in the adult circulation. If it did, we should not see the alimentary canal of the fœtus loaded with matter, and yet not stimulated to action, but in a state of inactivity and torpor.

## SECTION II.

## OF THE PANCREAS.

THE Pancreas is a gland the largest of those which have been called conglomerated, that is, distinctly consisting of lesser parts united. It is of a long form like a dog's tongue, and lies across the spine, and behind the stomach. Its excretory duct opens into the duodenum.

The pancreas is confined betwixt the two lamina of the mesocolon, and it is united to them by a loose cellular membrane; it lies before the great mesenteric vessels: its small extremity touches the spleen, and is near the capsuli of the left kidney: but towards the right extremity it increases gradually in massiness until its head lodges upon the duodenum. It is like the salivary glands in its appearance, consisting of lobules successively smaller and smaller; and it also resembles them in the manner in which its duct is formed. The duct\* begins towards the left extremity by exceedingly small branches; these running together form a middle duct, which taking a serpentine course towards the great extremity, and increased by the accession of the lateral branches in its course, becomes nearly of the size of a writing quill. Now approaching the duodenum it unites to the biliary duct, and opens along with it into the duodenum. A valve has been described as in the extremity of the pancreatic duct, but it is

\* Ductus Virgungis.

certainly

certainly incapable of the action of a valve, as the bile has been found to have gone retrograde into the trunk of the pancreatic duct. Sometimes there are two pancreatic ducts, but more frequently the part of the gland next the duodenum, and which is called the round head of the pancreas\*, has an excretory duct peculiar to itself, which either opens into the duodenum separately from the main duct, by piercing the coats of the intestines nearer the stomach, or sometimes opens further down.

De Graff, Ruyfch and many others have made experiments to discover the nature of the secretion from the pancreas. Tubes were introduced into the ducts, and bottles were appended to them in living dogs, so as to catch the pancreatic fluid: it was found rouspy, insipid, and like the saliva. It has therefore been concluded, from the colour, structure, ducts, and secretion of the pancreas having so strict a resemblance to those of the parotid and submaxillary glands, that it is of the nature of the salivary glands of the mouth. The general opinion has been, that it is useful in secreting a fluid which dilutes and moderates the acrimony of the bile. More accurate chemical examination of the pancreatic fluid has not been made, or has not been successful in showing any peculiarity in it.

Considering the pancreas as a salivary gland, how great must be the quantity of fluid poured out by it, if, as we are entitled to do, we take the analogy of the

\* This is what Winslow calls the little pancreas, and is sometimes schirrous so as to compress the biliary ducts.

parotid submaxillary and sublingual glands. These salivary glands, although they may be said to surround all the jaws from the zygomatic process on either side, are nothing in massiness and size to the pancreas. Again, the pancreas is most plentifully supplied with blood-vessels. Besides lesser branches of arteries, the pancreatico-duodenalis gives two branches, which take an extensive course through it, and are joined by other mesenteric twigs; and twigs proceed from the vessels of the stomach, and even from the hepatic artery; but more particularly we have to observe the large branches bestowed upon it by the splenic artery, where it takes its course close upon it.

While the masticators are working, the parotid gland pours out so great a quantity of saliva, says M. Helvetius, that it is inconceivable, and what I should not believe, had I not seen it in a soldier of the guards. A cut with a sabre in the cheek had opened the salivary duct: the wound healing on the inside of the cheek left a fistulous discharge from the parotid duct. When he eat, there flowed from this hole a great abundance of saliva; so that during dinner, which is not long in the Hotel Dieu, it moistened several napkins. How much must flow from all the salivary glands? How much from the pancreas, which is greater than them all collectively?

Like the biliary secretion it is probable that the contents of the stomach passing the duodenum, or the bile flowing from the biliary ducts, form the stimulus to the discharge of the pancreatic fluid; and as we see that the morsel in the mouth will quickly produce an almost instantaneous secretion and discharge of saliva,



so we are led to conclude that the flow of pancreatic fluid may be as suddenly produced without the necessity of a reservoir, as in the biliary system. We naturally conceive that the effect of this fluid is to diminish the viscosity of the bile, and by diluting it to mix it uniformly with the food. There are however few facts to enable us to reason on the effects of the pancreatic fluid. If we give full credit to the experiments of Malpighi and Brunner we may conclude, that when the pancreas is taken away, the more acrid bile causes vomiting or voracious appetite by its stimulus. Schirrus of the pancreas has been found attended with a colic and slow motion of the intestines; which seems to contradict the result of these experiments on animals; but by the schirrosity and enlargement of the pancreas the biliary ducts may have been more or less compressed, and the retarding of the usual quantity of the biliary secretion might produce the slowness of the bowels\*.

\* According to the hypothesis of Silvius, the use of the pancreas was to supply an acid spirit or juice, and the biliary secretion being of the nature of an alkali, these two struggling together caused the separation of the chyle from the fæces. This good fight did not stop here, but these enemies being carried into the blood continued their warfare in the heart itself, and lighted up the vital flame there.

Nay, if we believe the experiment of F. Schuyl, (de Veteri Med.) this hypothesis was not without its proofs; for having tied in the portion of the duodenum of a living dog, where the pancreatic and biliary ducts enter, he saw the ebullition from this struggle of the acid and the alkali; and when he compressed the hepatic duct, the tumefaction of the intestine subsided; when he took off this compression it was again blown up. As this experiment has not succeeded since, as Haller observes, Schuyl was probably deceived by the peristaltic motion of the intestines.

## SECTION III.

## OF THE SPLEEN.

THE spleen is a viscus of an irregular, oval figure, and dark purple colour. It is attached to the great extremity of the stomach. It is soft in its substance; and has the peritoneal coat very delicate. We should be glad could we say that it is of a parenchymatous structure, for in truth little is known of its organization.

In treating of this subject we must be indulged in some speculation; and indeed it is privileged ground; for the history of the opinions regarding the supposed function of the spleen is full of loose conjectures or wild hypothesis, and nothing is as yet certainly known of its use.

## SEAT AND CONNECTIONS.

The spleen is seated in the left hypochondrium; above the left kidney; and under the protection of the false ribs; and of course it is under the edge of the diaphragm. It is connected with the stomach by the cellular membrane, by the omentum, and in a still more particular manner by the vasa brevia. It has also connections with the left extremity of the pancreas by cellular membrane, and the branches of the splenic vessels. Lastly, it has a firmer attachment to the diaphragm, by means of a ligament formed by the peritoneum\*.

The

\* Yet the spleen is very apt to change its situation, or to fall down under the protection of the false ribs. It is liable to en-

The spleen is of no regular figure. Where it is contiguous to the diaphragm it is uniformly convex: towards the stomach its surface, while it is hollowed out and concave, presents two sides, so that we say the whole mass is somewhat of a triangular form. The anterior edge of the spleen is notched with deep sulci; behind and at the upper part the margin is large and round.

The substance of the spleen is the most spongy, tender, and soft of the abdominal viscera; so much so that not only does the finger make an impression upon its surface, but it actually disorders and tears its vessels. After a successful injection the whole seems made up of vessels; and if any thing like acini or globules are to be observed, the microscope will show them to be accidentally produced by the fasciculi of vessels. It has a strict resemblance to the substance of the placenta. The spleen is seldom smaller than natural; often greatly enlarged. I have seen it equal to the liver in size, and filling the whole left side of the belly. It has been frequently found thus enlarged, without any peculiar symptoms indicating such a disease during life. From its soft texture and great vascularity, like the liver, it has been found rent by blows and falls; and wounds here, as in the liver, by opening the large vessels are suddenly fatal. Sometimes it is hard and schirrous, and marbled in its colour. There is seldom suppuration in it. The spleen has been

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largement in ascites. From which circumstances it will not be wonderful if it is wounded in tapping for the ascites. See *Monro on Dropsy*.

supposed

supposed to swell up and enlarge when the stomach is empty, and to be contracted when it is full. It has been observed, that it is large and spongy in those who have died a lingering death, or who have been long ailing: that on the contrary, it is smaller and firm in those who have died suddenly a violent death.

We are informed, that the blood of the splenic vein is peculiar, inasmuch that it does not coagulate like the blood in the other veins of the body\*.

That which more than any other circumstance excites our attention, is the great size of the blood vessels of the spleen. Both the splenic vein and the artery are of great size in proportion to the bulk and weight of the spleen; and in their course they are particularly tortuous. I conceive we may also draw consequences from the distribution of their branches to the stomach (*viz.* the *vasa brevia* and left gastro epiploic) and to the pancreas. Its lymphatics are numerous. It is supplied with nerves, but has very little sensibility. It has no excretory duct.

#### OPINIONS REGARDING THE USE OF THE SPLEEN.

Of the various uses of the spleen, the lowest conjecture in respect to ingenuity or probability is, that like a sand-bath it foment the stomach, and promotes the process of digestion. This notion is perhaps not inferior in absurdity to that opinion which ascribed to the spleen the office of forming an acid juice, which being

\* With regard to this point I have no opinion, having hitherto neglected to examine the fact.

carried by the *vasa brevia* into the stomach, was supposed to excite the appetite \*.

It was a better conception that the spleen is the seat of melancholy; "that moping here doth hypochondria fit:" or of "laughter holding both his sides," of which the holding of the sides was an evidence. And again, since tickling the ribs is a demonstration of the effect from this excitement of the spleen †, that the growth of the spleen promotes laughter to such a degree, that it becomes a permanent silly *simper* impertinently excited. Nay further, we have authority for the excision of the spleen from those who are otherwise incurable in their propensity to laughter.

The following is a theory which has been very commonly received. A great quantity of blood is imported into the spleen with a slow motion, owing to its serpentine course. When the stomach is empty, the blood is received in a greater quantity by the spleen, where it has an opportunity of stagnating. Here the blood fermented, attenuated, and in a manner dissolved by the

\* I am mistaken in calling this the lowest in absurdity. The spleen has been considered as the seat of the soul! the cause of venereal appetite! the gland which formed the mucilaginous fluids of the joints! The atrabilis was received here concocted and transmitted to the liver. It drew forth and formed blood from the stomach, &c. Other physiologists, not contented with the theories presented to them, and yet incapable of suggesting others more likely, have very modestly asserted that the spleen was of no use at all.

† *Risus in liene sedes videtur ex effectu titilationis nataque in plurimis mortalibus risum excitat.* &c. Haller. His sober objection is, that tickling the right side will do as well as the left.

neighbour-

neighbourhood of the putrid fœces in the colon, enters upon the first steps of a begun putrification. By this resolving of the blood it is made more fluid, in which state it is returned by the veins, there being no excretory ducts. Now when the spleen is compressed between the distended stomach and the ribs, and the contracting diaphragm, the blood is pressed out from it in greater quantity and celerity towards the liver, mixing with the sluggish blood in the trunk of the vena portæ, replenished with the fat and oil of the omentum, it dilates it and prevents its stagnation and tendency to congeal. In short, the spleen has been supposed to be subservient to the function of the liver, and to the preparation of a watery (and subalkaline) fluid to the blood of the portæ. Another opinion has been, that it counterbalanced the mass of the liver seated to the right side of the belly.

Hewson entertained a theory regarding the use of the spleen which sullies his high character and reputation. He conceived that the spleen added the flat vesicle of the globules of the blood: his only observation in way of proof was, that he saw a few red globules returning by the lymphatics of the spleen: the effect, I have no doubt, of the injury of its substance, or of the compression of its vessels. It seems to me strange that such a man seeing the large splenic artery throwing its full tide of perfect arterial blood into the spleen, full of globules, complete in every respect, and again seeing a few globules carried back by the lymphatics, should imagine that this artery formed these few vesicles with which it was already so fully charged.

Of late years we have seen men endeavouring to raise themselves into notice by an attachment to the opinions of their departed patrons ; by supporting those opinions ; by holding, as they imagine, the proofs and illustrations of them in their possession : but seldom do we see the memory of great men honoured by such obsequies. The officiousness of Hewson's friends in promulgating his opinions has done no honour to his memory. They have attempted to support, on insufficient grounds, what he might have had the ingenuity to render plausible, and which are very far from honourable to his reputation, imperfect as they now appear.

I conceive the spleen to be an organ subservient to the stomach : and not only the constant attachment of it to the stomach in the human body, but the constancy with which it is found connected with the stomach in the lower animals, confirms the opinion. I regard it as a provision for giving the vessels of the stomach an occasional power and greater activity, enabling them to pour out a quantity of fluid proportioned to the necessity of the digestion. In the first place, let us examine the course and form of the splenic artery, and I think we shall find the great peculiarity of its size, and tortuous form, and strong coats, a provision for occasional great increase of power ; while, if not roused by the peculiar sympathies which actuate it, it is of a form to retard and weaken the velocity of the blood. This is founded on these propositions :

1. The muscular power of an artery increases as it recedes from the heart ; the elastic power diminishes.
2. An artery, the nearer it approaches to its final distribution, is the more immediately under the excitement

ment and controul of the organ; is active when the organ is excited; is, relatively speaking, quiescent when that organ is not called by its sympathies to exercise its function.

3. An artery tortuous in its course has more muscularity and greater power of action than one which takes a straight course; but in proportion to the increase of power which it obtains by its increase of length in this tortuous and bending course, will these turns retard and weaken the force of the heart upon the extreme ramifications of the vessel.

Thus a tortuous artery is the means of increasing the velocity of the blood by its own action, but it makes the organ less dependent on the general force of the circulation. We accordingly find that in those organs where there is occasional activity alternating with a quiescent state, the artery is tortuous; and where there is an increase of force required in the circulation, there, the artery, from being straight in its course, becomes crooked and twisted in every way\*.

From these remarks, we may be inclined to draw, from the tortuous figure of the splenic artery, a conclusion somewhat different from that which has hitherto

\* This has been supposed the effect of the impulse of the blood, but nothing can be more fallacious. Let any one examine the artery of a limb when a great tumour is growing; the artery will be found tortuous to supply it. Again, in the aneurismal varix where there is a breach in the artery, and the blood finds a freer return to the heart, the artery will be found enlarged and tortuous in order to supply the lower part of the limb; while there is a quantity of the blood withdrawn from the circulation by the communication with the vein.



been deduced. We may conclude that it is not the means of retarding the blood in its circulation, but of giving force to it. The splenic artery does not only ramify in the spleen, but it supplies all the left part of the stomach, and that great sacculated extremity in particular which receives the food, and in which the process of digestion is chiefly performed. My idea is, that when the stomach is empty, when there is no food in it to solicit the discharge of the gastric fluid, the blood circulates in a moderate degree in the coats of the stomach, and the spleen receives the surcharge of blood; but when a full meal is taken into the stomach, when the action of the gastric juice is required in great quantity, the action of the splenic artery is solicited to the vasa brevia and left gastro-epiploic artery, and thus a sudden flow of the gastric fluid is bestowed by the increased activity of the splenic artery. When again the contents of the stomach are fully saturated with the fluids from its coats, there is no longer an excited action of the splenic vessels, and the artery terminating in the veins, the spleen returns the blood to the liver. While the vessels of the stomach partake largely of the supply of blood, the arteries to the pancreas also receive some increase of activity; and even the blood of the vena portæ requires an additional activity.

We have seen that the stomach and intestines, the liver, pancreas, and spleen are combined in function, connected by the same system of vessels, mutually subservient to each other, and tending to the same end, the reception, digestion, and first stage of the assimilation of nutritious matter to the system. We leave this subject therefore until we can take up that of absorption

tion

tion and the lymphatic system, and pass to the kidney and viscera of the pelvis.

## SECTION IV.

## OF THE KIDNEY.

THE kidneys are distinct from those parts which have hitherto engaged us, as they secrete the urine, and form therefore the link betwixt the viscera of the abdomen and those of the pelvis; for though lying in the abdomen, they are more strictly connected with the parts in the pelvis. The structure of the kidney forms a very interesting subject of inquiry; because it is the field of dispute betwixt the contending parties regarding the structure of glands and the theory of secretion. It is chiefly from the kidneys that the facts are drawn in illustration of the opinions of Malpighi, Ruysch, and all the others.

**FORM, SEAT, AND CONNECTIONS.** The kidneys lie on each side of the spine; sunk as it were in the fat of the loins; attached to the muscles of the loins; and in part lying on the lower belly of the diaphragm; which last connection is the cause of the pain felt in respiration during inflammation in the kidney. The kidney lies betwixt the spine of the ilium and the lowest rib. The right kidney is placed somewhat lower than the left, which is owing to the greater size of the liver on that side.

The kidneys are without the abdomen, that is to say, behind the peritoneum; for the kidney lying close upon

upon the muscles of the loins, the peritoneum is merely stretched over it. This is the reason why calculi in the kidney have wrought themselves out by fistulæ in the loins; and it is the ground of the hazardous proposal of cutting into the kidney to extract calculi.

The adipose membrane surrounds the kidney, and forms a perfect capsule; for it is this which is sometimes in an extraordinary degree loaded with accumulated fat. Upon this capsule the cæcum is attached on the right side, the colon on the left, and betwixt the kidneys and the intestines there is a strict sympathy, which is apparent in the nephretic colic.

The figure of the kidney is that of an oval bent, or a little incurvated, so as to form a fulcus or general concavity to one side, while the other takes a greater convexity. By the concave surface of the kidney, which is towards the spine and great vessels, the arteries and veins and ureter pass in by the sinus round which the substance or glandular body of the kidney terminates abruptly.

The abdominal aorta and the vena cava lying close on the spine and near to each other, give off laterally the emulgent arteries and veins. The renal or emulgent artery comes from the side of the aorta betwixt the upper and the lower mesenteric arteries: that of the left kidney has its origin a little higher than the right: and the aorta being on the left and the cava towards the right side of the spine, the left emulgent artery is shorter than the vein; the artery longer than the vein on the right side. Again, the aorta being more closely attached to the spine, the emulgent vein lies rather above the artery.

The

The vessels, and especially the arteries of the kidney, are very irregular in their number and form. Where they enter the body of the gland, they are accompanied with a capsule which continues with them to this final distribution. Sometimes a solitary vessel is seen making its exit by the convex surface of the kidney.

We have had occasion to remark on the nerves of the kidneys and their connection with the coverings of the testicle, and to notice their effect in producing numbness of the thigh and retraction of the scrotum in inflammation of the gland, when stones lodge in the pelvis or ureter.

Upon the subject of the sensibility of the kidney, however, we must be aware that disease, inflammation, suppuration, nay even total wasting of the kidney may take place without any indication from pain.

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The excretory duct of the kidney is called URETER: it leads from the kidney to the urinary bladder. When we trace it into the kidney it is found to enter the naval-like fulcus of its concave side; here it is enlarged into a considerable sac which is called the PELVIS of the kidney. This is a kind of reservoir which, lying in the embrace of the solid and glandular part of the kidney, sends up several elongations almost like the finger of a glove, which receive into them the papillæ, the concentrated uriniferous tubes. These processes of the pelvis are called the COLICES or INFUNDIBULÆ.

It may be observed, however, that the term pelvis is taken from the greater dilatation of the ureter within the

the

the gland, which is seen in brutes; and that in man it is not so remarkable, the ureter branching with only a lesser degree of the sacculated form into three or four divisions, and these into the lesser infundibuli.

The coats of the ureter are three in number; a dense outer coat; a middle coat, apparently consisting of circular muscular fibres, though this has been denied; and a smooth inner coat, (very improperly called villous,) which secretes a mucus to defend it from the acrimony of the urine. The ureters do not run in a direct course to the bladder of urine; they take a curving direction; are in some places irregularly dilated, as when they pass over the psoas muscle\*, dropping deep into the pelvis, and getting betwixt the rectum and bladder they open obliquely into the latter.

#### MINUTE STRUCTURE OF THE KIDNEY.

The ancients, says Malpighi, contented themselves with the idea of a sieve, as conveying a knowledge of the manner in which the urine was drawn off by the kidney; that the fibres of its parenchymatous matter attracted the serum of the blood; that the fibrous matter was perforated with innumerable foramina; or that the whole was a congeries of canals through which the urine was strained and drawn off. Malpighi set himself to refute these vague opinions by the minute examination of the structure of the kidney; and he seems

\* When the bladder is contracted in consequence of a stone, or when it is dilated by obstruction, the ureters are dilated also; particularly in the first case. Whilst they are dilated, their coats become thickened, and their course is tortuous.

to have known almost all that we now know. Though we do not acquiesce in his opinions regarding the final and minute structure, he describes accurately every part of the gland.

*Capitate Renales.*



*The Lobulated Kidney of the Foetus.*

In the first place, when we examine the outward appearance of the kidney of the foetus, as in this annexed plate, we observe that it is not, like that of the adult, smooth and uniform; but that it is tuberculated or lobulated; that it consists of distinct parts, or glands united together. Again, when we examine the kidneys of other animals, we find in several instances that the full-grown animal retains this lobulated form. In short, it immediately strikes us that the kidney is not a uniform mass of glandular matter, but that it must resemble those glands which they call conglobate, and which consist of several compartments or distinct glands united together.

Accordingly a section of a kidney shows us that this is the fact.

The



The \* section of the kidney shows us these parts. First, we see towards the surface that which is called the cortical or glandular part E. Secondly, striæ, converging towards the centre of the kidney, being

\* *Explanation of the annexed plate.*

A B C D. The several divisions of the kidney which give it the lobulated figure.

E E. The cortical part of the kidney, being the outer, and, it is supposed, the secreting part.

F F. The tubular part of the kidney.

G. The papilla, or that part which projects into the calyx or division of the pelvis.

H. The perceptible ducts in the point or apex of the papilla.

I I I. The other papilla.

L. The point of one of the papilla which we see projecting into the pelvis.

M. The pelvis of the kidney.

N. B. This represents only one half of the kidney.

what



what is called the tubular part of the kidney \*. These tubuli are divided into fasciculi, taking a conical shape; and these converging unite at the apex; two or three of them united form the papillæ. The papillæ are generally ten or twelve in number, or even more, in each kidney; their points are received into the extremity of the infundibula; they pour the urine into these tubes, and it is collected in the pelvis. Now when we examine one of these papillæ in a lobulated kidney, we find that it is the centre of one of these subdivisions. Thus,



A A. Cortical Substance. B. Tubular part.  
C. Papilla. D. Ducts.

The papilla C is merely the continuation of the tubuli B; but it is that part which projects from the body of the kidney into the calyx; and although these divisions of the substance of the kidney are enumerated as three distinct parts, the cortical, tubular, and papil-

\* Improperly medullary, sometimes STRIATA SULCATA. FF.



lar parts, they are properly only two, the cortical and tubular parts.

Some however have made a new distinction, by asserting that a vascular part is to be observed betwixt the cortical and tubular or striated parts, as at \*; but it is not the case; for although when we make a regular section of the whole gland, the mouths of some larger vessels will be observed betwixt the fasciculi of the urinary tubes, yet they are irregular ramifications tending to the outer cortical part, and not such as separate the tubular and cortical part, nor so regular as to be considered as one of the subdivisions of the kidney.

#### OF THE CORTICAL PART.

The external and cortical part of the kidney is by all allowed to be the secreting, or, as they rather term it, the secreting part of the organ. It was this part which the older writers considered as in a more particular manner to consist of a peculiar fleshy substance or parenchymatous matter. It is in this cortical matter that the glandular bodies described by Malpighi are supposed to be seated. The appearances which he describes are to be very distinctly seen in many animals; for example, in the horse's and cow's kidney; and are to be seen represented in these plates. But he asserted these bodies to be also observable in the human kidney; to demonstrate which he ejected a black liquid mixed with spirit of wine, by which the kidney becoming universally tinged, you may then see, he said, when you have torn off the coats of the kidney, small glands  
partaking

partaking of the colour of the arteries. These are the glands of the cortical part of the kidney, which Malpighi described as hanging upon the branches of the arteries like fruit upon the pendant branches, and round which the arteries and veins ramified and convoluted, like delicate tendrils, so as to give them the dark colour which they have.

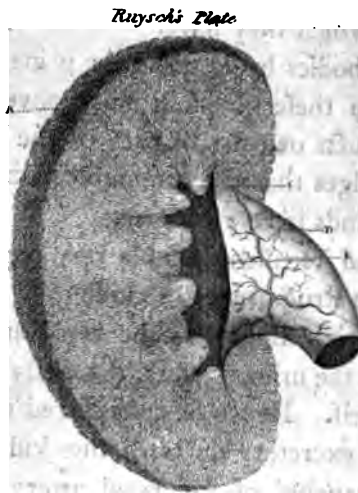
Into these bodies he supposed the urine to be secreted, and from these bodies it was conveyed into the uriniferous ducts or tubular part of the kidney; but he acknowledges that the communication betwixt the ducts and glands is very obscure.

Ruyfch and Vieussens held a very opposite opinion regarding the structure of the kidney\*. Ruyfch, by throwing his injections into the renal arteries, found that he filled the urinary tubes, the ducts of Belini, and the pelvis itself. Hence he conjectured that the tubuli uriniferi or excretory ducts of the kidney were the continued branches of the renal artery, without the intervention of any glandular apparatus†.

\* Ruyfch and Vieussens long contended for the claim of the discovery of the continuation of the arteries of the kidney into the urinary ducts. Ruyfch at first acquiesced in the opinion of Malpighi, as we have said.

† Thef. Anat. ii. p. 31.

## Example of Ruyfch's doctrine \*.



Ruyfch did not neglect the examination of the little bodies which are to be seen in the cortical substance.

He

\* Exhibet renis humani dimidiam partem ita dissectam, ut reptatus vasorum, presertim sanguineorum, loculentius quam in precedenti Thesauro, tab. iv. fig. iii. videre possit; ubi magis inherebam, ut conjunctiones arteriolarum cum ductibus Belini exhiberem, in hac autem figura distinctissime vasorum sanguineorum cursum vermicularem per interiorem renis partem exprimere volui.

A. Facies

He did not however allow they were glands, but confidently asserted that they were merely the convoluted arteries which were formed into these contorted bundles before finally stretching out, and terminating in the straight urinary tubes \*.

When after minute injection of the kidney we make a section of its whole substance, we see vessels emerging from the more confused intricate vascularity of the cortical part, and running inward in striæ towards the papillæ; what we see there, are, in my conception, chiefly veins. And this I conclude, both from the result of in-

A. Facies renis exterior per quam vasa sanguinea reptatum observant vermicularem.

B. Facies renis interior ubi vasa sanguinea non minus cursum vermicularem observant quam in facie exteriore.

C. Papillæ renales.

D. Pelvis renis.

E. Cavitas pelvis in quam papillæ urinam stillando expriment. — See Thesaur. Anat. W. p. 27.

\* In hoc Thesauro X. quoque inveniuntur objecta renalia ex homine desumpta, in quibus non solum luculenter apparet quid Judicandum sit de prætenfis glandulis renalibus, verum etiam quid investigatoribus renum imposuerit, se in renibus indagandis æpissime occurrunt corpuscula rotunda glandulas mentientia quæ revera nil sunt nisi arteriolarum ultimæ extremitates contortæ; cum autem exactissime repleantur arteriæ renales dissolventur vel expanduntur, quemadmodum fili glomer, ita ut nil minus sint, sicuti dixi, quam partes per se subsistentes, & peculiari membrana obductæ sine quo immerito dicuntur glandulæ. Interim considerandum ejusmodi contorsiones vasorum sang. nusquam in exteris visceribus reperiri. In the epist. to Boerhaave, p. 77, we find Ruysch speaking much more modestly: "In rene humano rotunda corpuscula esse, fateor, sed sunt tam exilia, ut nihil possim definire de illis. Adeoque non licet magis dicere quod sint glandulæ, quam aliud quid."

jections, and from knowing that the veins are in general numerous surrounding the excretory ducts ; besides they retain the blood in them like the veins. These vessels running in straight lines and converging towards the papillæ are not the tubuli uriferi, but the blood vessels accompanying them, the tubes themselves being transparent.

Yet I imagine it was by these vessels that Ruysch was deceived ; for tracing them from the extreme arteries, and seeing them suddenly altered in their form and direction, and running towards the Papillæ, he imagined them to be the excretory ducts continued from the extreme branches of the arteries.

Winslow supposes the corpuscles, which are seen in the cortical part of the kidney, to be the extremities of the cut tubuli, filled either with blood or with a coloured injection. But this they evidently are not ; for by making the substance around them transparent, they are seen within the surface, and they are little grains not the extremity of tubes, nor extended in lines.

Boerhaave, although he saw in the preparations of Ruysch the injection passed into the uriferous tubes, yet in the main favoured the opinions of Malpighi ; and having sometimes observed these tubes filled with injections, while at intervals they were transparent or pale, and contained only a watery fluid, he ventured to conclude that there was a double operation going forward in the kidney ; that the pale watery urine was quickly drawn off by the continuous tubes ; but that the urine of the other quality and higher colour was separated by a more perfect and slower secretion through the glandular bodies.

In the history of opinions, to Boerhaave succeeds Bertin, who writes a long and laboured paper in the Memoirs of the Academy of Sciences for 1744; upon the whole, he may be considered as endeavouring to prove by dissection what was rather an hypothesis with Boerhaave. Bertin describes glands in the substance of the kidney; but these he is careful to distinguish from the corpuscles of Malpighi, which he also conceives to be the extremities of vessels merely.



From this plate we shall easily understand Bertin's description. He observes, in the first place, that there are to be seen serpentine vessels, such as Ruysch described: for example, at A A A\*, which arising at the

\* Mesches de M. Winslow ou vaisseaux spongieux de Vieussens ou tuyaux serpentans de Ruysch.

circumference of the cortical substance, are reflected inward in a tortuous form, and which, at last, approaching the tubular part, terminate in straight tubes, or are continued into the tubuli uriniferi (for example at B B).

But betwixt the meshes of vessels which are described, and which are seen here to terminate in the tubuli, there are beds of glands C C C, which acervulæ of small glandular bodies are as it were laid in the tract from the circumference towards the centre, and appear to terminate, or to be connected with the tubuli uriniferi as the arteries are.

M. Ferrein has opposed all these opinions in a paper of the Academy of Sciences for 1749. He asserts that the body of the kidney is neither composed of glands nor a congeries of blood vessels; that it is a peculiar substance, which when examined is found to consist of transparent vessels. These, he says, are wonderfully convoluted in the cortical part of the kidney, so as to resemble glands, and stretch in parallel lines towards the papillæ, where they form what is called the tubuli uriniferi. Amongst these transparent tubes, the blood vessels ramify to great minuteness, and accompany them where they are reflected directly inward to form the tubuli. Much ridicule, he observes, has been thrown upon the term *parenchyma* of the ancients; but notwithstanding he affirms that there is in all glands a substance dissimilar from the blood vessels, a gelatinous-like matter, which consists of or contains these pellucid tubuli.

**TUBULAR PART.**—The term here used is universally received; and all seem agreed that the striæ converging  
to



to the centre of the kidney, and taking a pyramidal shape are the excretory ducts. We have seen that they were supposed by some anatomists to be formed by the continuation of the extreme branches of the arteries; but this opinion we shall venture to say arose from the appearance of the blood vessels injected, which lie parallel and close to them. They are evidently transparent tubes, and probably the fibrous appearance of the whole pyramidal body formed by them is owing to the accompanying blood vessels. These lesser ducts, as they approach the papillæ, terminate in larger ducts, which finally open into the ducts of Belini at the point of the papillæ. The papillæ we have seen to be that part of the pyramidal body which projects into the calyx or infundibulum, and from their point little drops may be perceived to run (from the ducts of Belini) when they are compressed.

I have detailed the several opinions regarding the structure of the kidney; and neither do I wish here to vamp up an opinion from the aggregate of these contradictory reports, nor have I been able to draw a decided conclusion from my own experience. In truth, the observation from one dissection I have hitherto found so completely contradicted by other experiments, that I must conclude there yet remains much to be done in investigating the minute structure of the glandular viscera.

#### OF THE CAPSULÆ RENALES\*.

THE renal capsules are glandular-like bodies one attached to each kidney. The capsule is seated like a

\* *Glandulæ atrabiliaris renes succenturiatæ. Glandulæ renales, &c.*



cap on the upper end of the kidney. It is of a form like an irregular crescent, and suited to the shape of that part of the kidney to which it is attached; at the same time that it has three acute edges, or takes a triangular form.—(See the drawing of the kidneys of the foetus.)—The upper edge has been called *crista*, while the lower edges have the name of lobes. It is in the foetus that the renal capsule is large and perfect; in the adult it has shrunk, and no longer bears the same relative size to the kidney. In the foetus the renal capsule is as large as the kidney, and the capsules of each side are continued into each other, being stretched across the aorta and vena cava.

The vessels sent to this body are somewhat irregular; they come from the renal or emulgent arteries and veins, from the celiac artery or phrenic, or from the trunk of the aorta, and even from the lumbar arteries.

By separating the lobes of this body we find something like a cavity, which has been roundly asserted by some to be a regular ventricle; by others altogether denied. Finding a cavity, they supposed they must discover the excretory duct. Some conceived that it must be connected with the pelvis of the kidney; some with the thoracic duct; some with the testicle; but every thing relating to the use of this body has hitherto eluded research, and all is doubt and uncertain speculation. For my own part I rather conceive that this body is useful in the foetus, by deriving the blood from the kidney, that gland not having its proper office, of secreting the urine, to perform in the foetus.

PART THE SECOND.

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*OF THE MALE PARTS OF GENERATION.*



## OF THE MALE PARTS OF GENERATION.

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As there is no very accurate division betwixt the viscera of the abdomen and those of the pelvis; as the viscera of the pelvis, when distended, rise into the belly, and are in every respect like the abdominal viscera, many have objected to a division of the viscera of the abdomen and pelvis: nevertheless, there appears to be good reason for this division of the subject. The function of the parts is different; the manner of their connection is different; their diseases have widely different effects.

We have seen that the pelvis consists of the sacrum and ossa innominata, and that anatomists have distinguished the true and the false pelvis. The false pelvis is formed of the extended wings of the ossa ilii, and supports the viscera of the abdomen. The true pelvis, marked by the cavity sinking beneath the promontory of the sacrum and the linea innominata, contains the rectum; the urinary bladder; the prostate gland; the vesiculæ seminales; and part of the urethra.

The manner in which these parts are connected, and the anatomy of the urinary bladder, prostate gland, and urethra, will form the subject of the first section; while the anatomy of the parts connected with those of the pelvis in function, but seated without, will form the subject of the second.

## C H A P. I.

## OF THE PARTS WITHIN THE PELVIS.

**W**E have seen that the abdominal viscera are involved in a common membrane; that this membrane is uniformly smooth; and that it has a secretion on its surface which bedews the whole, and allows the parts an easy shifting motion on each other. The parts in the pelvis must also have motion, but they are at the same time more strictly connected; a loose cellular membrane is the medium of adhesion here: the parts are imbedded in cellular membrane, which is interwoven with muscular fibres towards the lower opening of the pelvis, and further braced by the levator ani muscle. This gives to the whole due support; enabling them to resist the compression and action of the abdominal muscles, which they must receive in common with the higher viscera of the belly.

By turning to the first plan in this volume we find, that the division of the parts in the pelvis and abdomen is not well defined; but we see that the peritoneum is reflected from the pubes over the urinary bladder, and mounts again upon the rectum. The line of division, therefore, is the peritoneum; while we understand how the bladder which belongs to the pelvis, being distended, carries the peritoneum before it, and rises into the abdomen.

## SECTION I.

## OF THE BLADDER OF URINE.

As the general nature of the urinary bladder is so well known, nothing is more superfluous than a general definition or description. It is attached behind the os pubis; is nearly of a regular oval, when moderately distended, with the ends obtuse; but from its connections, and the pressure of the surrounding parts, this regular extension is not allowed in the living body; it stretches more laterally; its forepart is attached broad to the back part of the os pubis; and, behind, it is opposed by the rectum. What the name would imply to be the lower part is above; for the *fundus* of the bladder is that part which, when distended, rises into the belly; the neck is where it terminates in the urethra behind the arch of the os pubis. When the bladder is empty, or contains only a moderate quantity of urine, it takes a triangular figure, the base of which rests on the rectum, and the apex is attached to the back of the os pubis; and when in dissection you look down into the pelvis, you find the back part of the bladder flat, and as it were stretched obliquely up upon the os pubis\*.

STRUCTURE OF THE BLADDER.—Like the other hollow viscera, the bladder consists of several coats.

\* This flatness of the bladder, and the nearness of the back part of it to the os pubis, the surgeon would do well to remember, before he thrusts the gorget or silet with such relentless impetuosity as I have seen done.

The

THE PERITONEAL COAT of the bladder does not surround the bladder, but only covers the fundus and back part. It is like in every respect to the peritoneal coat of the abdominal viscera; smooth without; and adhering to the inner coat by cellular membrane; which cellular membrane is, however, of a looser texture, and in greater quantity than in the abdominal viscera. This peritoneal coat is no doubt of much service as a division in obstructing the course of inflammation arising from the diseases in the lower part of the pelvis, or from operations performed on the bladder, rectum, or peroneum; were it not for the loose peritoneum spreading over the cellular texture of the pelvis, we could neither be so bold or so successful in our operations here. That portion of the peritoneum which covers the back part of the bladder, forms a particular transverse fold when the bladder is contracted. This fold surrounds the posterior half of the bladder, and its two extremities are stretched towards the side of the pelvis, so as to form a kind of lateral ligament.

Though in the contracted or moderately distended state of the bladder, the peritoneum stretches from the back of the os pubis to the bladder, the distention of the bladder, in an immoderate degree, raises the peritoneum off from the pubes, so that the bladder can be struck with a trochar, or lithotomy performed above the pubes, by an incision directly into the bladder, without piercing the outer or peritoneal coat.

Towards the lower part, the bladder, as we have seen, is invested only by cellular membrane, which takes the place of the peritoneal coat of the fundus. While we are aware of the effect of the peritoneum, stretched

stretched over the parts in the pelvis, in obstructing the progress of inflammation from the bottom of the pelvis towards the abdominal viscera, we must recollect that there exists such a sympathy betwixt the bladder, and the stomach and bowels, that both after operation, and in consequence of obstruction of urine, the patient will sink, in consequence of abdominal inflammation, without the direct spreading of the inflammatory action.

MUSCULAR COAT.—The muscular coat of the bladder is very strong. Three strata of fibres are described by authors. They are so strong as to have been classed with the distinct muscles, and the whole coat has been called DETRUSOR URINÆ. Towards the lower part of the bladder the fibres are particularly strong, and formed into fasciculi, and are like a net of muscles inclosing the bladder.

Towards the neck of the bladder the circular fibres are strengthened; and embrace the beginning of the urethra; and form a sphincter, which, no doubt, is assisted in its operation by the levator ani muscle, throwing its strong fibres around the neck of the bladder. The muscular coat of the bladder becomes greatly stronger, where difficulties oppose its discharge; and when there is a source of irritation, within the bladder, acting for any time, the whole coats become thickened, sometimes to the depth of half an inch or more; in which case, as we have observed, to take place in the stomach, it is capable but of a very inconsiderable change, either by detention or contraction; consequently the urine runs frequently by painful discharges. The lithotomist would do well to distinguish when this symptom is merely the consequence of a stone



in the bladder, and when it is owing to an increase in thickness, and a rigidity of the coats of the bladder; for, in the latter case, the operation of the gorget is attended with very serious evils.

We have an idea of the wonderful degree of contraction in the bladder, and indeed the extent of motion in the muscular fibre in general, when we consider that the bladder extends so as to contain two pounds of urine, and contracts so as to force out the last drop from its cavity. When, however, the fibres are stretched too far, they lose the power of contraction, and often the young surgeon is deceived by what he conceives to be an incontinence of urine while it, is really an obstruction.

#### VASCULAR COAT, OR CELLULAR COAT.

When I call this third coat of the bladder the vascular coat, it is merely from its analogy to that coat of the intestines which I have distinguished by the name of vascular. Anatomists have called it the nervous and cellular coat; the first of which is quite improper and the last apt to be confounded with the surrounding cellular outer coat. This coat (if coat it may be called) consists of very extensile white lamellæ of cellular membrane. It gives distribution to a few vessels, and connects the muscular fibres and inner coat.

THE INTERNAL COAT of the bladder is very smooth on its general surface, and is bedewed with a sheathing mucus. When the bladder is distended, no inequalities are to be observed; but when contracted it falls into folds and rugæ. From an acrid state of the urine;  
from

from strangury, from calculus, the mucous discharge is increased, even so as to form a great proportion of the fluid evacuated from the bladder. No visible source of this mucus is to be observed on the inner surface of this membrane \*; so that probably it is a general discharge from the surface. Indeed, it appears, that no follicles or criptæ, discharging at particular points of the surface, could have the effect of bedewing and defending the whole surface from the acrimony of the urine. The great sources of the mucus discharged with the urine are, the neck of the bladder, the prostate gland, and the urethra †.

THE URETERS, which convey the urine from the kidneys to the bladder of urine, open very obliquely into the bladder, towards the back and lowest part of it. The consequence of their oblique perforation of the coats is, that, the greater the tendency of the urine to pass retrograde into them from the bladder, (there being a proportioned distention of the coats of the bladder,) the more their mouths are compressed. Thus, in the dead body, there is no degree of distention which causes the water to pass by the ureters. The contraction, or rather the resistance to distention, of the ureters and pelvis of the kidneys seems much greater than the powers of the bladder are able to oppose; for in obstructions of urine in the urethra,

\* Winslow, however, describes the glands, and Heister and Haller describe follicles, near the neck of the bladder, and round the insertion of the ureters.

† When the mucous secretion is diminished by a disease of the surface, it seems much more readily to allow the calculous concretion to form upon it.

there is still an incessant accumulation in the bladder, even when the bladder has increased to such a size as to be compressed by the action of the abdominal muscles. The cause of this yielding of the bladder to the secretion of the kidney is, that it has little permanent contraction, though occasionally its action is very great.

The URÆCUS does not belong to the human bladder. It is a tube which, in the foetus of quadrupeds, communicates betwixt the bladder of urine, and the membrane called alantoes. But in the human foetus there is no such communication; both in the foetus, and somewhat less distinctly in the adult, there is a ligament like the remains of the duct which runs up between the peritoneum and linea alba of the abdomen towards the umbilicus\*.

## SECTION II.

### OF THE PROSTATE GLAND.

ON the neck of the bladder, and surrounding about half an inch of the beginning of the urethra, there is a gland nearly of the size and figure of a chestnut. This body is called the prostate gland. In all the extent of anatomy, there is not a more important subject for the attention of the surgeon than this of the size, relation and connection, and diseases (with their effects) of the prostate gland: but to enter upon these is not now our object.

The shape of this body is round, but at the same time somewhat pyramidal, for it is broad towards the

\* It has occurred, that the urine has been in part discharged by the umbilicus. This, no doubt, is owing to the ligament remaining permanently as a duct.

bladder,

bladder, and points forward. It has also a division, forming it into two lobes; and the older anatomists speak of it as double. The urethra passes through it; not in the middle, but towards its upper surface; so that the gland is felt more prominent downward, and is distinctly felt by the point of the finger *in ano*. This gland indeed rests, as it were, on the rectum. By the annexed drawing \*, it is meant only to give an accurate conception of these parts, and not to represent them as they are felt in the living body. For this reason the drawing is made from a preparation, and not from the recent dissection. When the catheter is introduced, and the surgeon examines the state of parts by the rectum, he will first distinguish the curve of the staff, covered with the bulb of the urethra: behind this the catheter will feel more bare of parts, but still covered with a greater thickness of parts than one should expect from the description of the membranous part of the urethra. And behind this, again, he will feel the prominence of the prostate gland, not round, distinct and accurately defined, but gradually lost in both before and behind, among the surrounding cellular membrane and muscular fibres which involve it.

The texture of the gland is a compact spongy substance, and when cut has considerable resemblance to a schirrous gland. From each lobe there are small follicles opening into the urethra, and from these the ducts may be injected.

\* Plates III. and IV.

It has been said, that there is really no division of this gland into lobes : but perhaps the best authority on this question is disease. Now it happens sometimes that only one side of the gland is enlarged, which is a proof that there is some division betwixt the lobes. This unequal swelling of the gland distorts the urethra, and gives it a direction very difficult to be followed by the catheter. In general, when equally swelled, the greater part of the gland, being beneath the urethra, raises it up so that the point of the catheter must be raised over the enlarged gland before we can pass it into the bladder. This body is little liable to inflammation, and occasional tumefaction, so as to obstruct the urine ; its enlargement is a chronic state, and peculiar to advanced age.

## C H A P. II.

OF THE PARTS CONNECTED WITH THE VISCERA  
OF THE PELVIS, BUT SEATED WITHOUT IT.  
—OF THE PENIS AND URETHRA.—OF THE  
TESTES.

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## S E C T I O N I.

OF THE PENIS AND URETHRA.

## STRUCTURE OF THE PENIS.

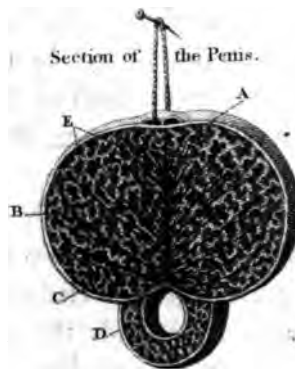
THE penis consists of three spongy bodies; which, being constituted to receive the influx of blood, admit of distention, and consequent erection. Two of these bodies are called the CORPORA CAVERNOSA PENIS, and form the body of the penis; the other is the CORPUS SPONGIOSUM URETHRÆ, a vesicular and spongy substance, which surrounds the whole length of the urethra, and expands into the bulb of the urethra in the perineum, and into the glans on the point of the penis.

CORPORA CAVERNOSA. The body of the penis consists of two tubes formed of a very strong sheath. This sheath has a great degree of elasticity, but at its utmost extension powerfully resists the farther distention with blood. These tubes are united in the greater part of the length of the penis, or they are parted by an imperfect partition. The root of these bodies,

or CRURA PENIS, as they are called, separate in the perineum, so as to take hold on the ramus of the os pubis. Foreward, these bodies or tubes terminate in rounded points under the glans penis.

These tubes are of a ligamentary nature, bating that they have a certain degree of elasticity. They inclose and support the cavernous structure of the penis. This substance consists of cells connected with each other and having a free communication through the whole extent of the penis. These cells are interposed betwixt the extremities of the arteries and veins, or probably while the arteries have communication, and open into the extremities of the veins, in the common way, they have such connections with the cellular structure, that in the accelerated action they pour their blood into the cells; yet the blood circulates in the penis during erection as at other times.

*Section of the Penis as inflated.*



A, Corpus Cavernosum Penis. B, Septum. C, Urethra. D, Corpus Spong. Minus, or spongeosum Urethræ.

#### CORPUS SPONGEOSUM URETHRÆ.

Surrounding the urethra there is a spongy body similar to that which forms the body of the penis. Where this spongy sheath of the urethra lies in the perineum, betwixt the crura of the penis, it is enlarged with a round head, which is called the bulbous part;—it is upon this, and on about an inch and an half of the lower part of the spongy body, that the ejaculator seminis, or accelerator urinæ acts; and, as within this enlargement of the spongy body which surrounds the urethra there is also a dilatation of the tube of the urethra itself, the use of the muscle is evident. It contracts upon this sinus of the urethra when distended with the discharge from the vesiculæ, the prostate gland, and testicle. As an accelerator urinæ, it cannot act, but it expels the last drop of urine, as a consequence of their detention in this more dilatable part of the urethra.

The spongy sheath of the urethra, as we have hinted, is enlarged into the GLANS, so that the action of the accelerator muscle affects the whole length of the spongy body of the urethra and the glans by the compression of the blood in the bulb.

There is a connection betwixt the glans, spongy tube of the urethra, and accelerator muscle. The excitement of the glans gives the action to the accelerator or ejaculator muscle; the action of this muscle



compresses the bulb, and in consequence the whole spongy body to the extremity of the glans is made tense, elongates, and contracts the diameter of the urethra, adapting it to the emission of semen. Mr. Home, I observe, supposes "that an action takes place in the membrane of the urethra during copulation, to reduce the size of the canal, and fit it for throwing out the semen with the necessary velocity:" but for this, there seems no ground nor proof; and I imagine, the action of the accelerator, and the state of distention of the spongy body, will be a good substitute to his conjecture.

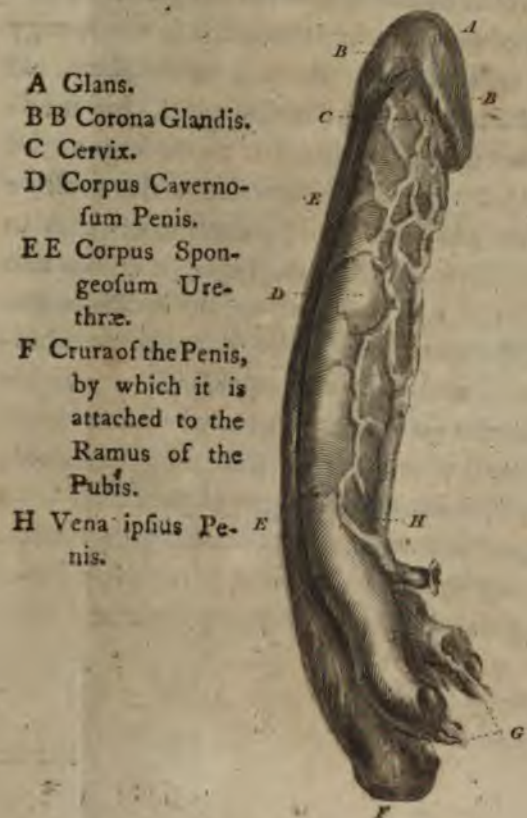
The obtuse point of the glans is spread upon the extremities of the cavernous bodies of the penis, which yet have no communication with the glans. We observe a circular margin, the corona glandis, and behind this the cervix. About the corona and cervix there are many little glandular follicles\*, which are no doubt for preserving the mobility of the preputium.

THE PREPUTIUM is a loose prolongation of the integuments of the penis, which hangs over and defends the delicate and sensible surface of the glans. Its inner surface is of course the continued surface of the common integuments, while it again is reflected over the glans. Upon the lower side the preputium is tied in a particular manner to the surface of the glans behind the orifice of the urethra. This connection limits the motion of the preputium, and is called FRENUM PREPUTII.

\* Glandul. odorif. of Tyson. See Morgagni.

The whole integuments of the penis are of the same cellular structure with those of the rest of the body, and may be with equal facility inflated: they are particularly loose and distensible, and unincumbered with fat.

A third common integument of the penis is distinguished, and is called the tunica nervosa. It is of a more firm elastic ligamentary substance. A ligament, however, is not elastic, and the firmness here is merely that of a greater degree of condensation in the common membrane. It is this membrane, which being attached to the os pubis, and supporting the penis, forms the ligamentum elasticum suspensorium.



- A Glans.
- B B Corona Glandis.
- C Cervix.
- D Corpus Cavernosum Penis.
- E E Corpus Spongiosum Urethrae.
- F Crura of the Penis, by which it is attached to the Ramus of the Pubis.
- H Vena ipsius Penis.

## OF THE URETHRA.

The urethra is all that length of the canal from the neck of the bladder to the extremity of the penis. It is formed of the continuation of the inner and third coat of the bladder, which last forms a reticular membrane, uniting the inner membrane to the spongy body. It is, however, supported through all its length, near the bladder, by passing through the prostate gland and sphincter fibres; further forward than this, where it passes from the prostate to the beginning of the spongy body of the urethra, it is invested and supported by firm cellular and ligamentous membranes; and in the length of the penis it is included in the spongy body, which extends from the bulb to the glans. It cannot be described as a cylindrical canal, for it admits of very unequal distention. It begins large at the neck of the bladder, where, immersed in the prostate gland, it forms a little sinus; it is contracted again in a remarkable degree behind the bulb; it dilates into the SINUS OF THE URETHRA within the bulbous enlargement of the spongy body; it is gradually diminished forward; and it may be considered as cylindrical forward to the point of the glans, where it is much contracted\*, and where we often find calculi detained, which have passed the whole length of the canal.

The canal of the urethra is bedewed with mucus. The sources of this mucus are here particularly apparent; for, besides the general surface, there are large

\* Haller Com. lib. xxvii. sect. i. § xxx. Mr. Home's Strictures.

lacunæ seen ; into which the mucus is secreted, and from which, as from receptacles, it is pressed as the urine flows. The inner membrane of the urethra is very delicate, and, when torn by the catheter, or by violent chordee, or opened by the caustic, bleeds profusely.

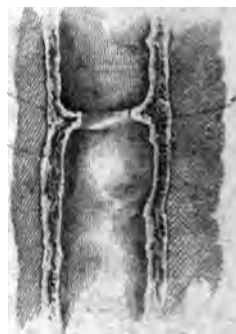
The internal membranes of the bladder and urethra are particularly sensible ; drawing after them, when excited, not only the action of all the muscles in the lower part of the pelvis, but having sympathies in a particular manner with the testicle, stomach, and bowels, and with the whole system. The more curious and important effect of the injury of the urethra is the paroxysm of fever which it induces. Observing the regular occurrence of an intermitting fever in cases of fistula in the perineum, we should imagine it to be the effect of the extravasation of the urine in the cellular membrane, and the effect of general irritation ; until it is observed that the simple stricture produces that effect, and that a touch of the caustic brings on a violent paroxysm.

When the reticular membrane is inflamed, of course it loses its elasticity, and gives pain in erection. Sometimes the inflammation, being continued to the spongy body surrounding the urethra, makes it unequal in its capacity of distention to the cavernous bodies of the penis, and sometimes their cells are united by adhesion in the worst cases of chordee.

I cannot imagine with some, that the urethra is muscular ; *first*, because I see no end it could serve in the œconomy ; *secondly*, because there is no proof in support of the opinion ; *thirdly*, because it is surrounded

rounded with strong fibres and a spongy body, which conjointly seem calculated for every purpose of the œconomy, and likely to account for every symptom which might be mistaken for spasmodic action in the canal itself. The idea of muscularity is derived from the symptoms of stricture and irritability of the canal. I shall therefore, in the first place, shew how I conceive stricture is produced.

The urethra is very elastic; not only allowing a very large bougie to be passed, and closing upon a thread, but it still more remarkably admits of elongation than of distention in the width of the canal. It is surrounded, as we have seen, with a spongy body and the cellular coat which is betwixt the delicate lining membrane of the urethra, and the spongy body partakes of the structure of both, and is very elastic. But when an inflammation attacks the canal, this cellular membrane is its principal seat. The point affected loses its elasticity; no longer stretches with the penis and urethra, but consolidates, and throws the inner membrane into a fold in a direction across the canal. Thus the membrane at A has contracted and condensed in consequence of inflammation, or rather, when contracted, by the shrinking of the urethra in length and its spongy body has formed an adhesion, and, in consequence of inflammation, has lost its elasticity and no longer dilates in the pro-



portion

portion of the rest of the canal. The consequence of this is, that the point of the inner membrane B makes a projecting ring round the urethra. To suppose this stricture to have been formed by the muscular contraction in the diameter of the canal \*, would be to allow the partial action of one or two fibres; (for the stricture is like that which would be produced by the tying of a pack-thread round the canal, being a narrow circular ridge;) which is very unlikely. Sometimes, however, the stricture is only on one side of the canal, which, allowing it to be formed as I have here supposed, is very likely to happen: but in consequence of the muscular action, cannot easily be supposed to take place, since the drawing of the muscular fibres would equally affect the whole circle.

As to the effect of heat and cold on an obstruction, it may be explained simply, without the supposition of muscular contraction: for as we know that the penis, spongy bodies, and of course the whole canal, relax and elongate in warmth, as they are shrunk up and contracted in cold, like the skin of the body in general, without implying muscular contraction: so we see how this state would affect a stricture;—that, when the penis and the urethra was shrunk, the effect of the stricture would be increased, and the patient could pass his urine only when the parts were relaxed, by sitting in a warm room, or by the use of the bath.

\* “A stricture,” says Mr. Home, “whether in the spasmodic or permanent state, is a contraction of the transverse fibres of the membrane which forms the canal.”

But

But when surgeons speak of spasms of the urethra, they seem to forget the action of the surrounding muscles. Thus acrid and stimulating urine, or an irritable state of the urethra, will be followed by a small stream of urine: or perhaps a temporary obstruction is the consequence; but why should we suppose that the membrane of the urethra, which has no appearance of muscularity, causes this effect, when it is probably produced by the sphincter muscle, the fibres which surround the membranous part of the urethra, the levator ani, and, above all, by the accelerator urinæ, a muscular sheath of fibres surrounding three or four inches of the canal. Round the membranous part of the urethra, and behind the bulb, there is much interlacing of muscular fibres; and the levator ani, splitting, embraces it. Round the sinus of the urethra and the bulb which covers it, is the accelerator urinæ, more properly the ejaculator seminis: and as the ejaculator seminis contracts upon the sinus, it drives onward the semen along the urethra, since the seminal fluids do not pass backward into the bladder, unless when the action of the parts is much disordered; there must be a contraction round the urethra behind the bulb during the action of the ejaculator. The sensibility of the glans holds a controul over the action of these muscles; and the disease of the bladder and of these parts affects the glans. There is, in short, a complicated apparatus here, and we cannot wonder, that the most frequent seat of disease is just at the beginning of the sinus of the urethra, where the muscular action is stronger, and the canal narrowest. At this place is the stricture of the urethra most common, and here

if spasm and muscular action should bring it on, if spasmodic action should prevail during the permanent stricture, or blistering bring on a strangury, (seeing that this point is so surrounded with muscular fibres destined to a particular action,) we must not take these symptoms as indicating a muscularity in the whole tract of the urethra. I believe it is found, that stricture is most frequent just behind the bulb of the urethra; where I have alleged, the muscularity is greatest; and also about the distance from the extremity of the urethra which answers to the termination of the ejaculator muscle.

## SECTION II.

## OF THE TESTES.

THE TESTICLE might be considered as more naturally connected with the abdominal viscera, than with those of the pelvis, as its original seat is on the loins amongst the abdominal viscera, and as it receives its coats from the peritoneum, and its vessels from the abdominal vessels.

The testes are two glandular bodies which secrete the semen: they receive their vessels from the aorta and cava, or the emulgent vessels; their excretory duct runs up into the belly, and it terminates in the urethra near the neck of the bladder.

THE SCROTUM, in which the testicles are lodged, is a continuation of the common integuments; its cellular membrane is particularly lax and free from fat, and anasarca extremely apt to fall down into it, so



as sometimes to distend the scrotum to a transparent bag of enormous size; and not unfrequently it has been blown up to counterfeit rupture and other diseases.

The cellular substance of the scrotum is peculiar in its appearance, being red and fibrous. It has been considered as a muscle, and called *DARTOS*: although this is denied by many. Its action is to support and brace the scrotum; and in bad health\*, and in old age, it is so much relaxed as to allow the testicles to hang upon the chords. But besides the simple corrugation and relaxation, the scrotum has a motion like the vermicular motion of the intestines, from side to side, and alternately. Its contraction has a relation to the healthy secretion of the gland within.

Upon the surface of the scrotum, directly in the middle, there is a line passing from the lower part of the penis to the anus; the *RAFHA*. This line marks a division in the scrotum, not superficial merely; but a partition, or septum, is formed, dividing the scrotum into two distinct cellular beds for the testicles.

**COATS OF THE TESTICLE.** Besides the involving scrotum, each testicle has two distinct coats, the *tunica vaginalis* and *tunica albuginea*. The *tunica vaginalis* covers the testicle loosely; that is, without adhering to its general surface: but the *albuginea* is in close union with it, and is the immediate coat of the testicle. The inner surface of the vaginal coat is perfectly smooth, and an exudation is poured out from

\* Nurses particularly attend to the state of the scrotum in children.

it as from the peritoneum within the belly, the outer surface of the tunica albuginea is also smooth and firm, and white, whence its name. But on its inner surface, like the peritoneum, which covers the intestine, and adheres to the muscular coat, it adheres to the tubes of the testicle itself. These investing coats are in some respects dissimilar, yet in general much alike, being continuations of the same membrane, and both prolongations of the peritoneum. The outer membrane, the tunica vaginalis, is a protection to the testicle, gliding easily on the inner coat, and with the mobility of the cellular membrane of the dartos it preserves the testicles from bruises and strokes to which it would be exposed if it were more firmly attached. The inner tunic, or albuginea, gives strength and firmness to the substance of the testicle. Betwixt these coats is the fluid collected, which forms the hydrocele. They also contain the congenital hernia; but the common hernia is without both coats of the testicle. To understand the principles of anatomy of this part, we must attend to the descent of the testicle, and to the manner in which these coats are formed.

## OF THE DESCENT OF THE TESTICLE.

In the foetus, some months before birth, the testicles are lodged in the belly, and are in every respect like the abdominal viscera. They are seated on the fore part of the psoas muscles, by the side of the rectum. They are of course covered and invested by the peritoneum; for, as we have explained how the

solid viscera and the intestines are behind the peritoneum, so it will be understood how the testicles lying on the loins are behind the peritoneum: that is to say, the glandular substance of the testicle is invested by a single coat, and that coat is the peritoneum, which, after covering the body of the testicle, is reflected upon the loins; as the coats of the liver, for example, are to be traced from its surface to the diaphragm: no words, however, can well explain this subject, and it will be better understood by sections and plans.

*First Plan of the Testicle.*



We see that the body of the testicle A is seated on the loins, that it is attached by vessels, and invested by

by the peritoneum. This surrounding of the body of the testicle by the peritoneum forms that coat which is in union with its substance, and which descends with it into the scrotum, and forms the tunica albuginea.

The figure and presenting surfaces of the testicle, while within the belly, are the same which we find after it has descended into the scrotum. It stands edge-ways forward, and the epididimis lies along the outside of the posterior edge of the testes. We see that it is attached, by the peritoneum being reflected off from its back part, and we can trace the peritoneum upwards over the kidney G, and downward over the rectum F, and bladder of urine E.

We may also observe a process of the peritoneum which has passed through the abdominal ring, and which in this plan is marked D. Now it may easily be understood that the testicle A, gradually shifting its place from its connections in the loins, drops down into this sheath D. It will also be easily understood how the testicle covered with its first coat B, (*viz.* the tunica albuginea,) when it has fallen into D, is invested by this sac of the peritoneum, and that this last covering will come to be the tunica vaginalis. The tunica vaginalis is so called because it covers the testicle like a sheath; that is, it does not universally adhere to the surface of the albuginea, as that coat does to the body of the testicle.

Understanding the nature of the peritoneum, we may learn the meaning of this looseness of the outer coat of the testicle. By turning to the introductory section of the abdominal muscles, we find, that the

inside of the sac of the peritoneum is smooth, and forms no adhesion; whilst the outer surface, being in contact with the substance of the several viscera, has a connection with them by a common cellular membrane. Now, as the inside of the peritoneum does not adhere, as the surface of the peritoneum, (which in this first plan is towards C,) is smooth, and has no tendency to unite with the surface of the viscera; so neither has the surface of the peritoneum at D, the tendency to unite with the peritoneum (or the surface of the albuginea,) at B, when it descends to meet it: consequently the coat of the intestines may be represented in this second plan, thus.

*Second Plan of the Testicle.*

*2<sup>d</sup> Plan of the Testicle.*



*3<sup>d</sup> Plan of the Testicle.*



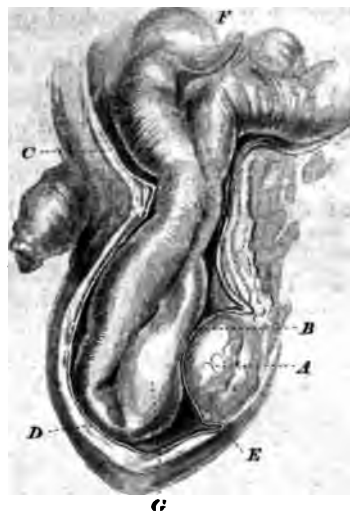
In the first plan, we had the situation of the testicle in the foetus represented. In the second plan, we have

have the middle stage of the descent represented : and, in the third, we have the full descent. In the second figure, A is the body of the testicle, B is the first peritoneal covering or tunica albuginea, which can be easily traced, reflected off from the loins at C ; again, D is the portion of the peritoneum, which having descended before the testicle is presently, when the testicle has fully descended, to become the second, or vaginal coat of the testicle ; F is the continuation of the peritoneum upon the inside of the abdominal muscles.

In the third figure of this series, we find the testicle A has descended into the scrotum ; that it has one coat covering it, which we recognize to be the same with B, in the first figure, and that the peritoneum in this third plate at B, can be traced to C, the peritoneum within the belly.

Now supposing this to be the state of the testicle immediately after it has descended, we see that there is still a communication betwixt the cavity of the tunica vaginalis D, and the cavity of the peritoneum E. F is the kidney, covered by the peritoneum, and nearly in the situation in which the testicle was before its descent.

*Fourth Plan of the Testicle.*



From this fourth plan of the testicle, we may learn the nature of the congenital hernia. It is a hernia produced by the intestine slipping down, from the communication betwixt the general cavity of the peritoneum, and the cavity of the tunica vaginalis, or in consequence of an adhesion betwixt the testicle and a portion of the gut, which of course causes the gut to follow the testicle, and prevents the communication betwixt the belly and the cavity of the tunica vaginalis from being shut. Thus fig. 4. A, is the testicle, as it is seen in plan 3d. B, the tunica albuginea; C, the peritoneum within the belly; D, the tunica vaginalis, which we can trace from C, and which is distended and separated from the surface of the testicle, (*i. e.* of the albuginea,) by a portion of the gut, which has descended through the ring: F, the intestines within the belly: G, the intestine which has fallen into the tunica vaginalis, and is in contact with the testicle; that is, in contact with the tunica vaginalis, which is in close union with the gland, and is considered as its surface.

We have explained the change which takes place in the situation of the testicle, as it relates to the peritoneum; but how this change is brought about, it is very difficult to understand. It is not a sudden pulling down of the testicle, but a very gradual process, continuing for months; it is not the effect of gravitation, for the foetus may be in every variety of posture while in the womb, and generally the head presents. It is not respiration. Is it then the effect of the action of the cremaster muscle? or must we refer it to a law such as that

that which controuls and directs the growth of parts?

When the parts in a fœtus before the descent of the testicle are dissected, there is found a ligamentous, or cellular cord, mingled with the fibres of the cremaster muscle, and which takes its origin from the groin, is reflected into the abdominal ring, and stretches up to the body of the testicle. This body is called ligament or gubernaculum, and to the agency of this bundle of fibres, is the descent of the testicle attributed. There are, however, objections to this. If we suppose that the cremaster muscle, by its exertion, brings down the testicle to the ring, How does it pass the ring? for surely we cannot suppose that this muscle, which takes its origin from the internal oblique muscle, consequently within, can contract, not only so as to bring the testicle to the very point of its origin, but to protrude it past that point, and through the tendon of the external oblique muscle. Again, animals have the cremaster muscle, whose testicles never descend out of the belly;—again, the vessels of the cord, before the testicle has fully descended, show no marks of being dragged down, for they are elegantly tortuous.

As the testicle passes very slowly from the loins to the ring; so, after it has escaped from the belly, it passes slowly from the ring to the bottom of the scrotum. It commonly remains some time by the side of the penis, and only by degrees descends to the bottom of the scrotum\*.

In

\* Mr. Hunter has shewn, that the detention of the testicle in the belly is in consequence of some defect and want of action in



In this change the testicles do not fall loose into the elongation of the peritoneum like a piece of gut or omentum in a rupture;—but, carrying the peritoneum with them, they continue to adhere to the parts behind them, as they did to the psoas muscle while in the loins: a point of importance to be recollected by the young surgeon.

The communication betwixt the belly and the sac of the vaginalis is very soon obliterated by the adhesion of the upper part, and then the whole extent of the passage (viz. from E to D, in plan 3d of this series,) is shut. When this process is prevented in the first instance, when nature is balked in the humour of doing her work, as Mr. Hunter observes, she can not so easily do it afterwards.

It has also occurred that, this communication remaining after birth, a hydrocele has been produced by the distention of the tunica vaginalis, by fluids descending from the belly. The character of such a tumour will be, that the fluid will be easily forced into the belly. It may, however, be mistaken for a congenital hernia\*.

It will already be understood, that in the common hernia of the groin or scrotum, the gut does not pass by the communication from the belly into the vaginal

the testicle, and that those who have the testicle remaining in the belly have it imperfect or small. This is contrary to an old authority:—The testicles are seated externally, “for chastity’s sake, for such live-wights as have their stones hid within their body, are very lecherous, do often couple, and get many young ones.”

\* Such is the remark of Mr. Hunter.

coat; that such communication no longer exists, and that when there is a rupture from preternatural wideness of the abdominal ring, or in consequence of a great violence, a new portion of the peritoneum descends with the gut before the cord of the testicle,

*Fifth Plan of the Testicle.*  
Hernia.



This 5th plan will now illustrate the relation of the testicle to the herniary sac in the common scrotal hernia. A, the scrotum: B, the testicle; which will be easily understood to preserve its attachment to the back part of the scrotum: C, the tunica vaginalis, which here invests the testicle, but which is not now (in the adult or perfect state of the coats of the testicle), as is seen in plan 3d, open from D to E, but forms a short sac surrounding the tunica albuginea: D, the cellular membrane of the cord of vessels passing down to the testicle. And now there are no remains of the tube of communication.

communication betwixt the belly and vaginal cavity; it is obliterated and resolved into this cellular membrane.

We see then, that in this plan the testicle and its coats, and the spermatic cord, are in their natural situation, and that the herniary sac has descended before them. E, is the ring of the external oblique muscle of the abdomen, through which not only the testicle, with its coats and vessels, has descended, but also the hernia: F, the herniary sac, which contains a portion of the gut; it is formed of the ~~peritoneum~~, fallen down from the belly, but it is quite distinct from the sac of the tunica vaginalis C. ~~Whilst this new~~ process of the abdominal peritoneum has descended, it has contracted adhesions, and cannot now be replaced.

In thus explaining these important principles of anatomy, and which the anatomical student will find wonderfully to facilitate the more minute study of surgical anatomy, it only remains to show the nature of the hydrocele.

The hydrocele is a collection of water within the sac of the tunica vaginalis; that is, betwixt the tunica vaginalis and tunica albuginea. For, as we have seen, that the same surface of the vaginal coat is contiguous to the surface of the testicle (viz. the albuginea,) with that of the peritoneum, which is contiguous to the viscera of the belly; and as it has the same exudation, so it has the same disease, viz. a collection of water, from the absorption being disproportionate to the exudation. When the tunica vaginalis is distended with the water of a hydrocele, the testicle is towards the back part of the scrotum; it can be felt there; and when

when the scrotum is placed betwixt the candle and the eye, we see the transparent sac on the fore-part of the tumor, the opaque mass of the testicle behind; generally the distended vaginal coat stretches up before the cord conically. Thus,

*Sixth Plan of the Testicle.*



A, the penis; it is generally corrugated thus, in consequence of the distention of the scrotum in scrotal hernia and hydrocele: B, the scrotum: C, the testicle, covered only by the tunica albuginea: D, the cellular membrane of the cord: E, the tunica vaginalis, distended with the water of the hydrocele, and consequently separated from the surface of the testicle: F, that part of the sac of the vaginal coat, which often extends

convoluted, and form a mass of vessels, which has been called the corpus pyramidale\*.

The nerves of the testicle, like the blood-vessels, come from the loins, and are continued down upon the vessels in the spermatic plexus. This still farther allies the testicle to the abdominal viscera, giving them much of the same sympathies. The stomach, intestines, and testicle, sympathise readily with each other. As we find the tunica albuginea of the testicle to be very firm, dense, and unelastic, the great pain in inflammation of the testicle has naturally been attributed to the resistance made by this coat to the swelling of the substance of the testicle, but much must be ascribed to the natural sensibility of the part, independently of swelling and tension; for in the very moment of a blow, a person faints and falls down from exquisite pain.

The lymphatics of the testicle are numerous, and easily demonstrated by blowing up the cellular structure of the body of the testicle; and we shall by-and-by find, that this has been the ground of dispute between physiologists; and the proofs of some important points in the doctrine of absorption have been drawn from the injection of the lymphatics of the testicle and cord.

\* Corpus varicosum,—Corpus Pampiniforme; Galen de Semine. Alias parastatam varicosam, Hall.—As the old physiologists saw and observed this wonderful tortuosity, and the tendril-like form of the spermatic artery, they thought that as there must be something peculiar in this structure, the blood was here begun to be changed into semen, and therefore they called them the vasa preparantia.

THE



THE CREMASTER MUSCLE, as we have seen in the first volume, takes its origin from the internal oblique muscle of the abdomen, and, passing down over the vessels of the cord, is expanded on the tunica vaginalis: its use is to suspend the testicle, and prevent it from dragging upon the vessels of the chord.

By constitutional weakness, or the relaxation induced by warm climates, this muscle becomes relaxed, and artificial suspension becomes necessary. Sometimes this muscle draws the testicle spasmodically to the groin; yet I cannot allow that this is the muscle which retracts and corrugates the scrotum, for the testicle will be thus drawn up by the cremaster, without corrugation or contraction of the scrotum. In some this would appear to be a voluntary muscle; it possibly accelerates the motion of the semen, or at least promotes its secretion.

Thus we find the cord of the testicle, as it is called, to consist of the arteries, veins, and nerves; of the lymphatics returning from the testicle; of the cellular tissue embracing and supporting all these vessels; and lastly, of the fibres of the cremaster muscle.

#### OF THE STRUCTURE OF THE TESTICLE.

It is to De Graeff that we owe the knowledge of the structure of the testicle; and indeed the merit of this great anatomist has not been acknowledged with sufficient gratitude by modern anatomists: but after the fervour of disputation has subsided, the merit of ingenuity and of discovery must return to him to whom it is due. No one more highly values than I do the improve-

improvements of anatomy by the Hunters and Monro : but I must say, that the structure of the testicle was demonstrated by De Graaff to his fellow anatomists of Montpellier, and his discoveries published in a manner so perfect, as to leave us little to learn from more modern authors.

De Graaff, by exciting animals to venery, and tying the spermatic cord, had the seminal vessels distended. He did not depend upon injections ; by maceration and dissection in this distended state, he unravelled all the intricacies of their tubes. More modern anatomists have proved the truth of his observations by injections of mercury, and have succeeded in a variety of ways of preparing the testicle.

**TUBULI TESTIS.**—When the tunica albuginea testis is lifted, the body of the testicle is found to consist of innumerable very delicate white tubes ; which, when disentangled from the minute cellular membrane which connects them, and floated in water, exhibit a most astonishing extent of convoluted vessels. By a closer attention, however, to this structure before it is thrown into confusion by pulling out the tubes, they appear to be regularly laid in partitions of the cellular membrane. These septimenta are very regular in some animals, and while they separate the seminal tubes, they support and convey the blood-vessels to the secretion of the semen. Dr. Monro has denied the formal divisions which De Graaff had engraved, but acknowledges them less regular, less easily found, and not so limited in their number ; nor does he find them to prevent all communication betwixt the tubes of the testicle.

These

These seminiferous tubes of Haller, or tubuli testis of Monro, running in meshes, 15 or 20 in number, terminate on the back of the testicle. Each of these tubes seems to be cylindrical, or of one diameter throughout their whole extent: we see no communication betwixt them; no branches given out or going into them; no beginning for the whole, nor for any one of them. Though we cannot prove it, yet there seems to be only one tube wonderfully convoluted and folded up in each subdivision of the testicle.

RETE TESTIS.—When the tubuli come out from the body of the testicle, they run along the back of it, and communicate by anastomoses with each other, so as to form a net-work of vessels, from which appearance Haller named them rete testis.

Here it often happens that the mercury stops, when it has been injected backward from the vas deferens; and it is this part which has been better described and drawn, in consequence of mercurial injections, than it was by De Graaff; for he, as we have said, saw this part only filled with semen.

Connected with the rete testis is the CORPUS HIGHMOREANUM.—Where the lines of the membranous septa, and cellular membrane of the testicle, meet on the back of the testicle, and under the epididimis, they form a white line. This white line running along the testicle, was supposed by Highmore to be a hollow tube; it was compared with the salivary duct; it was thought to be a cavity leading from the body of the testicle to the head of the epididimis, and to form the communication by which the semen flowed from the testicle. De Graaff first refuted this notion, and shewed



that it was not by this one great duct, but by these smaller tubes forming what has been now called the rete testis, that the semen came from the testicle : still it had continued a question, whether this white line was really solid, or a tube ; and upon faithful examination of the point it appears, that this is expressly as it was explained by De Graaff, viz. that it is a mere collection of the membranes of the body of the testicle, forming a *linea alba* ; and as the septa are more distinguishable in some animals, so is the *corpus high-morianum* \*.

**VASA EFFERENTIA.**—The tubes running on the back of the testicle, and forming the rete testis, we have understood to arise from the *tubuli testis* ; now it is the continuation of the rete testis which is called *vafa efferentia*. The *vafa efferentia* are very delicate vessels which run out from the head of the testicle, single at first, but they are soon convoluted, and by these convolutions they are formed into an equal number of vascular cones, which constitute the head or larger part of the epididimis. These *vafa efferentia* and vascular cones are connected by a very delicate cellular membrane ; and it is a piece of very nice dissection to display them after they are injected with mercury.

**EPIDIDIMIS.**—The *vafa efferentia*, after forming thin conical convolutions, unite and form larger tubes ; these again uniting, form one large excretory duct, the *vas deferens* : but this vessel being convoluted to a wonderful degree, forms a body, which, being as it

\* This body called a mere *firmamentum* or binding, Winslow ; the nucleus testis.

were, placed upon the testicle, has been called epididimis.

~~Fig. 7.~~ *Plan of the Testicle.*

*7<sup>th</sup> Plan of the Testicle. p. 1195.*



In this representation of the dissected testicle, *A* is the body of the testicle divested of its coats; *B*, the tubuli testis \*; *CC*, the rete testis; *D*, the vasa efferentia; *E*, the vascular cones; *F*, the epididimis formed of the convolutions of the vas deferens; lastly, *G* is the vas deferens.

In the substance of the testicle there are no glands nor follicles; the arteries minutely ramify amongst the seminal tubes, and, there is reason to believe, secrete the semen into them. The seminal vessels in the substance of the testicle, or tubuli testis, run together upon the surface of the testicle, and form the rete testis. From the rete testis are continued the vascular cones: these

\* Where the tubuli are emerging to form the rete vasculosum, they are called the *vasa recta*.

convolute, and running together form the epididimis ; from which the tube is continued under the name of the vas deferens. It passes up the chord ; enters by the ring into the abdomen ; and then passing down into the pelvis, terminates in the vesiculæ seminales, in a manner presently to be explained. It is not likely that the vis a tergo, the power of the arteries, pushes the semen through all this length of tube, of which the epididimis itself is reckoned to be several feet in length, if the various convolutions were undone. Such an action on the testicle as that of the dartos or cremaster muscle, could give only a general stimulus, but could not force on the semen in tubes which take so a great a variety of directions. We are therefore left to the supposition, that these tubes themselves have a power of accelerating the fluids through them.

Of the lymphatics of the testicle we shall afterwards treat ; it is, however, necessary here to remark, that Prochaska found in his injections a difficulty in making the mercury pass the rete testis into the testicle. Observing at the same time in his preparations, and in the drawings of all authors, an appearance of irregularities in this part like the valvular structure of lymphatics, he has been led to suppose that there is a provision here for preventing the semen from being forced backward into the testicle by the action of the cremaster muscle ; he conceives that when the cremaster muscle draws up the testicle to the groin, it may accelerate the semen in the epididimis, whilst this valvular structure prevents the regurgitation upon the delicate vessels of the substance of the testicle.

The







*Vol. IV. Plate II. fronting p. 297.*



*Published for Longman & Co. May 9<sup>th</sup> 1844*

The annexed plate represents the appearance which I have found in my preparations. A, the vas deferens by which the mercury was injected; B, the epididimis; C, vessels running up the chord from the great head of the epididimis.

There is a duct which sometimes arises from the epididimis, and which has been found to terminate abruptly in a blind end—of this, Mr. Hunter speaks in the annexed note \*.

#### OF THE TESTICLE IN GENERAL.

The testicle is of an oval form, and of the size of a pigeon's egg: it is a little flattened on the sides: it

\* “ By a supernumerary vas deferens, I mean a small duct, which sometimes arises from the epididimis, and passes up the spermatic chord along with the vas deferens, and commonly terminates in a blind end, near to which it is sometimes a little enlarged. I never found this duct go on to the urethra, but in some instances, have seen it accompany the vas deferens as far as the brim of the pelvis. There is no absolute proof that it is a supernumerary vas deferens; but as we find the ducts of glands in general very subject to singularities, and that there are frequently supernumerary ducts, there being often two ureters to one kidney, sometimes distinct from beginning to end, at other times both arising from one pelvis; these ducts, arising from the epididimis, I am inclined to believe from analogy, are of a nature similar to the double ureters. They resemble the vas deferens, as being continuations of some of the tubes of the epididimis, are convoluted where they come off from it, and afterwards become a straight canal passing along with it for some way, when they are commonly obliterated.

“ The idea of their being for the purpose of returning the superfluous semen to the circulation is certainly erroneous, from their being so seldom met with, and so very seldom continued further than the brim of the pelvis.”



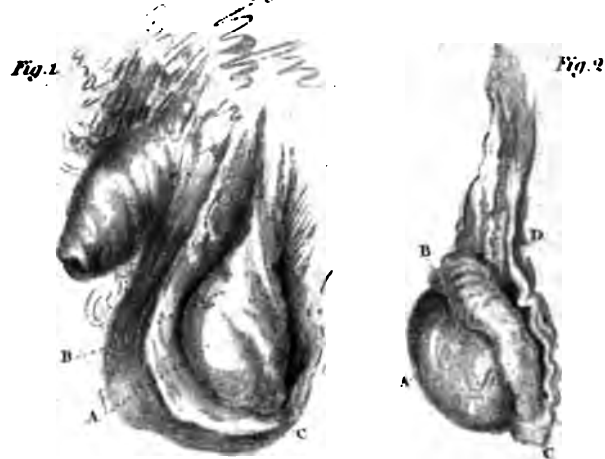
hangs in the scrotum by the spermatic chord; one end of the oval, forward and high; see plan 8th B; while the other is backwards, and drops lower, C. The spermatic chord consists of the artery which brings blood; of the veins which return it; of the vas deferens, which carries the semen to the vesiculæ feminales at the neck of the bladder; of lymphatics, which are essential to the structure of every part. This chord of vessels comes down from the belly, and passes by the ring of the abdominal muscles; it is about four inches in length, and is fixed into the upper and fore part of the body of the testicle.

The body of the testicle is easily distinguished, and is the place where the secretion is performed. It is strictly the body of the gland, while the part above it is only the duct by which its fluid is discharged.

The ancients called the testicle dydimi, gemini, twins; they, therefore, called that part which is laid on the back of the testicle epididimis, as added to it. To the surgeon, it is essentially necessary to attend to the relation of the parts of the testicle as felt through the scrotum.

*Eighth Plan of the Testicle.*

*8<sup>th</sup> Plan of the Testicle.*



In this 8th plan, fig. 1. we see the testicle as in its natural situation, covered with its membranes, and appearing like one body; while, in the second figure, it being represented freed from its outer coat, we see the epididimis as laid upon the testicle, and consisting of the convoluted tube. First, we observe A, the body of the testicle; B, the beginning of the epididimis, or the large head of the epididimis\*. Then we see it laid along the back of the testicle, and observe C to be the small head of the epididimis†, where the tube is reflected to reascend upon the testicle, and to form D, the vas deferens.

Now, we have to observe, that the point C, fig. 2. or small head of the epididimis, hangs over the testicle, and points backwards to the perineum, and can be felt through the whole coats; and that the body of the testicle A, is towards us when we examine a patient—Further, as the letters in figure 1 and 2. refer to the same points, we have only to notice the fainter indication of the parts in fig. 1. it being invested with the coats; and to observe the general relation of the testicle to the scrotum and penis.

There is one other circumstance to be observed, viz. that the epididimis is always laid on the outer side of the insertion of the chord into the testicle; from which we distinguish, with ease, in a preparation, to which side the testicle belongs. Thus, in the an-

\* *Globus major*, or head.

† *Globus minor canda*. This part we often distinguish retaining its hardness after the subsiding of the general swelling of *hernia femoralis*. From this point we can trace all the connections of the other parts.

nexed plans, the testicle of the left side is represented, which we know from the points c, being directed backward, while the epididimis is laid along the left side of the insertion of the chord.

#### OF THE VESICULÆ SEMINALES.

Behind the prostate gland, and attached to the lowest part of the urinary bladder, lie two soft bodies, which are the vesiculæ seminales. They appear like simple bags when seen from without, but dissections show them to consist of a cellular structure; each of these bodies is about three fingers-breadth in length; their backmost point is large and round, and, at the same time, that they diverge from each other, their narrow points unite, or are contiguous to each other forwards, and enter at the back part of the base of the prostate gland.

As we have seen, the peritoneum does not descend far enough betwixt the bladder and rectum to cover or invest these vesiculæ; they are therefore involved in the cellular texture, and covered with strong fibres, besides being subject to the compression of the levator ani muscle. When the vesiculæ are cut into, and especially when they are distended, dried, and cut, they present a cellular appearance; but if they are carefully dissected, they present the appearance of a small blind intestine convoluted.

This cellular appearance is given by the duplication of their inner membrane, together with the distortions and curves of the canal. Their outer surface is co-

vered with a fine membrane, which, like a frenum, connects these cellular convolutions.

These are copiously supplied with arteries; their surface is covered with veins and lymphatics when these vessels are minutely injected, and their coat is thick and spongy. Heister, Winslow, and others, have described small glands as seated in their sinuosities; but these are confidently denied, and in their place there is described a pile or efflorescence. There can be little hesitation in affirming, that these vesiculæ are themselves glands, or, in other words, that the arteries secrete into them a peculiar fluid. The forepart of each of the vesiculæ, which we have said sink into the back part of the prostate gland, runs under the neck of the bladder, and opens by distinct mouths into the urethra, on the surface of the verumontanum.

The connection of the vas deferens with the vesiculæ, is very particular, it does not open directly into them, but opens with them into the urethra in such a way, that the semen from the testicle can pass into the vesiculæ, though its direct course is into the urethra\*.

If air is blown into the vas deferens, the vesiculæ will be distended at the same time that the air passes into the urethra: the union of the extremities of the vas deferens and vesiculæ, forms a kind of septum betwixt them.

The extremity of the vas deferens joins the duct of the vesiculæ where it is imbedded in the prostate

\* See explanation of plate III.

gland;

gland; the union of the vas deferens and duct of the vesiculæ is not attended with an enlargement of the duct; on the contrary, as the duct passes forward deep into the substance of the gland to arrive at the urethra, it becomes remarkably narrower until it opens in a very small orifice in the verumontanum, as we see represented in the third plate. The duct (if we may so call it,) of the vesiculæ passes a full inch forward into the gland before it terminates in the urethra.

These vesiculæ have been in general supposed to be receptacles for the semen; but as this is an opinion depending on the connection of these bags with the extremities of the vas deferens, and as comparative anatomy shows many instances of these vesiculæ being unconnected with the ducts of the testicle, there is much reason to doubt whether they really are merely reservoirs. They have always appeared to me as useful in adding a fluid to the secretion of the testicle, which being poured together into the sinus of the urethra, give a distention, exciting and giving effect to the contraction of the ejaculator seminis: For unless there were a provision of fluid sufficient to distend the sinus of the urethræ, the semen could not be thrown out from the urethra. This supposition is not opposed by the facts stated by Mr. Hunter, that in many animals the vesiculæ and vasa deferentia open by distinct foramina into the urethra, because in that case the fluids of these secreting bags might be equally mingled with the semen in the sinus of the urethra, although they do not flow from the same tube.

VERUMON-

**VERUMONTANUM.**—The verumontanum, or caput galinaginis, is an eminence on the lower part of the urethra, where it is surrounded by the prostate gland. As we observe in the drawing, it is larger and round towards the bladder, and stretches with a narrow neck forwards. On its summit, the two orifices of the feminal vessels open; and around it there are innumerable lesser foramina and mucous follicles.





Drawn by Chas Bell.

Engraved by Stuker.

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PART THE THIRD.

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*OF THE FEMALE PARTS OF GENERATION.*

Vol. IV.

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1

## THE ANATOMY OF THE PARTS IN THE FEMALE PELVIS.

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**T**HERE is considerable difficulty in presenting such a view of the anatomy of the parts of generation in woman, as may bear a due relation to this general system of anatomy, and, at the same time, be intelligible and complete. The subject is in itself extensive and important, sufficient to fill several volumes: it is much connected with practice; and the phenomena and diseases of the system serve greatly to illustrate the strict anatomy of the parts. I cannot here be allowed to give to it its due importance, whilst yet it is a subject not easily understood from a short abstract.

The parts of generation are divided into the external, which are those without the pelvis; and the internal, or viscera of the pelvis, and which lie within the bony circle of the pelvis.

## C H A P. I.

## THE EXTERNAL PARTS OF GENERATION.

THE external parts of generation are the mons veneris, labiæ, clitoris, nymphæ, urethra, hymen, or carunculæ myrtiformes. Upon these subjects we have no want of books and information ; for accoucheurs of the old school dwelt upon the description with particular accuracy. These parts were within their ken, which we cannot say of the viscera of the pelvis : and, therefore, upon the former we shall be more brief.

In very young children these external parts bear a large proportion to the body, greater than at any subsequent period before the age of puberty. At puberty they are suddenly and completely evolved, and acquire an increase of size ; while, from the age of two years to twelve or thirteen, there has been little increase. Immediately before menstruation, commences the connection which occasions, or accompanies that flux. It begins to effect the evolution of the uterine system, and to fit it for its peculiar function. The parts become turgid and vascular ; the fat is deposited in the surrounding cellular membrane. About the fortieth year, when the menses disappear, this fullness of the private parts also ceases, and the fat is reabsorbed.

The MONS VENERIS is that prominence on the symphysis pubis, which consists of the skin raised and cushioned up by the fat inclosed in the cellular membrane.

brane. There is of course a great variety in its size. In early life it is small: it becomes, as we have said, more prominent at the age of puberty; in fat women it is of an enormous size; and in some warm climates a particular laxity prevails. From the hair on this part, marking the age of puberty, it is called pubis. As the lax texture admits of distension with the fluid of anasarca, it is sometimes from this cause very greatly swelled.

THE LABIÆ. These are often named alæ, from a slight resemblance to wings, and they are also called externæ, magnæ, or majores, from their place, and from their superiority in respect of size over the nymphæ. The labiæ seem to be the mons veneris continued downward, and laterally until meeting below, they form the vulva; at their lower angle, by their union, they form the fourchette, or frenum labiorum. The structure of the labiæ is similar to that of the mons veneris; sometimes one is larger than the other.

The great sensibility of the membrane which lines the inside of the labiæ, requires some defence, and therefore the whole surface is amply supplied with mucous follicles and glands. The labiæ are a protection to the other soft parts, so necessary, that the clitoris, or nymphæ, when they project beyond them, are subject to violent inflammation.

The parts here have either such folds, or are of so lax a texture, as to permit a great degree of distension during the passage of the child. But, as the labiæ have no muscular power, and depend entirely on their elasticity for restoring them to their original size, they commonly, after being very much dilated, remain

in some degree larger and more lax. It is different with muscular parts, as the orificium externum, which, by the power of its sphincter, is restored after labour to its original size. In man, hernia descends from the abdominal ring into the scrotum; but, in woman, when there is a rupture from the ring, (which is rare) it may fall into the labiæ, though, I believe, it will be seldom found to descend thus far.

THE NYMPHÆ are named labiæ vel alæ minores, or labiæ internæ, to distinguish them from the great labiæ. They are like a miniature representation of the great labiæ; they are covered with a very delicate membrane, and have great sensibility. They begin immediately under the glans clitoridis, and seem to be only an extension of its preputium, formed by a folding of the membrane. Their size varies much. They commonly stretch downward, and backward to the middle of the orifice of the vagina; sometimes no further than to that of the orificium urethræ, and in a few instances they extend even the length of the fourchette \*. They are very vascular, and have somewhat of a cellular structure, and thus partake of a degree of turgidity, in consequence of irritation and vascular action. The most modest of the uses ascribed to them is, that of directing the stream of urine. As they are obliterated during the passage of the child's head through the vulva, it is probable that they facilitate the necessary dilatation.

The nymphæ are, in their natural situation, covered and completely protected by the labiæ externæ. When naturally large or increased by disease, or in a very

\* Both Riolin and Morgagni have observed the parts without the nymphæ.

relaxed

relaxed state, they are deprived of this covering : they project from under the labiæ, and are apt to become inflamed, and even to ulcerate. The original disease, or tumor, is augmented, or they become perhaps hard and callous. In children they bear a very great proportion to the other parts, and are more conspicuous and prominent than in the adult. Their diseased enlargement sometimes requires to be extirpated, in which operation, as they are very vascular, and as with their growth, their blood-vessels enlarge, considerable hæmorrhagy may be expected. A surgeon of this city, in extirpating a tumor of this kind from a young lady, thought his duty fulfilled when he had applied a piece of lint upon the surface after the operation, so that he even neglected to appoint an attendant. The hæmorrhagy returned, and continued so profuse that before the surgeon arrived the lady had fainted.

THE CLITORIS is similar to the male penis. Like the penis, it consists of cells for receiving blood, and in a similar manner, it arises from, or takes hold of the rami of the os pubis by two crura ;—these unite at the symphysis pubis, to form the body of the clitoris, which is suspended from the os pubis, like the penis, by a kind of ligament. The clitoris has also a kind of glans, over which the integuments make a fold like a preputium. In short, it has the same sensibilities, the same power of erection with the membrum virile ; only it has no urethra nor spongy body, like that of the urethra of man.

The stories of the increase of this instrument, even to its preeminence in size over the male penis, are very idle, but there seems to be a peculiar predilection for them.



them. It is not wonderful that a clitoris of such magnitude should suggest the idea of a hermaphrodite, or person partaking equally of the distinguishing attributes of either sex.

#### OF THE URETHRA.

The urethra of the female is short, straight, and wide; its length an inch and a half, or two inches; its direction nearly straight, or only slightly bending under the os pubis; and its diameter such as will admit a catheter the size of a writing quill. The consequences of these peculiarities are, that the catheter is easily passed when there is no very unusual obstruction; that women are not so much exposed to the disease of stone in the bladder as men, for though this is much owing to constitutional peculiarities, yet it is obvious, that when a small stone is formed, and passes from the bladder, it is easily discharged; and, lastly, that lithotomy is a very simple operation in woman.

The opening of the urethra is in a direct line under, or behind the clitoris, and about an inch from it: It is in the middle of a slight prominence, and its vicinity is plentifully supplied with mucous glands. If the relation of the orifice to the clitoris be observed, there is, in the natural state of the parts, no difficulty in slipping the point of the catheter, on the end of the middle finger, from the clitoris, until it is caught upon the lacuna-like orifice of the urethra; but even in this part of the operation, I have experienced great embarrassment, from an irregular ulcerated or cancerous surface of the parts, by which all the usual distinctions were lost.

From

From the length and sudden turns of the male urethra, from the double function it performs, and from its being embraced by the prostate gland, the obstructions of the urine are more frequent, and the catheter less easily passed, than in woman. The catheter too requires to be of a very peculiar form. The short and wide urethra of woman requires only a simple and almost straight tube: and although, accurately to adapt it to the course of the urethra, a considerable curve might be given to it, yet that is not necessary in common cases; and circumstances will occur to the accoucheur which will preclude the possibility of using such an instrument.

We shall only mention here such cases of obstruction of urine as are in a particular manner illustrated by the anatomy and connection of the parts. These are tumors of the ovarium, tumors of the womb, polypi, distension of the vagina, displacement of the womb, as *procedentia*, *prolapsus*, *retroversio*, &c.; and lastly, the child's head in labour.

The ovarium being enlarged, and falling down into the pelvis, either presses upon the neck of the bladder, causing obstructions, or pressing and weighing on the fundus of the bladder, it occasions a *stillecidium urinæ*.

Tumors of the womb, especially of the neck or orifice, as it is in contact with the urethra, very soon affect this organ. Thus, I have seen a cancer of the orifice of the womb, by exciting inflammation in all the surrounding parts, and by massing them together into a tumor filling the pelvis, occasion obstinate obstruction of urine.

Polypi attached to the orifice of the womb, and filling the vagina, produce the same effect. In all such

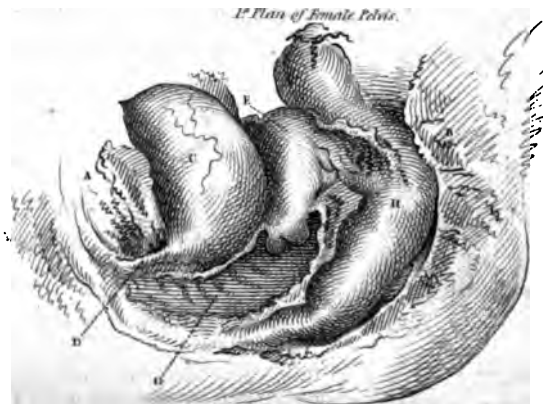
214 THE EXTERNAL PARTS OF GENERATION.

cases, perhaps, the tumor may be pushed up, so as to permit the flow of urine, or the introduction of the catheter.

A case occurred to Mr. John Bell, in which the tumor of the womb compressed the neck of the bladder. A catheter was passed, and gave instant relief. The midwife, after some time came, and said, that the catheter would not pass. He found that he could pass the catheter into the bladder, but no urine flowed; and it was discovered, that the tumor increasing backward, came to press upon the ureters, so as completely to obstruct them where they enter the bladder. The woman unavoidably died; each kidney and ureter was found to contain four or five ounces of urine.

A slight sketch of the parts in the female pelvis will, perhaps, better explain the connections of the neck of the bladder than any description, and will certainly better illustrate the cause of some kinds of obstruction, particularly that arising from the change in the posture of the womb.

*First Plan of the Female Pelvis.*



A, the os pubis cut through.—B, the spine and sacrum also cut directly down.—C, the urinary bladder moderately distended, and rising behind the pubis.—D, the urethra, very short, and taking a gentle curve under the symphysis of the os pubis.—E, the fundus of the womb.—F, the os tincæ, or orifice of the womb.—G, the vagina.—H, the rectum.

Prolapsus, or falling down of the womb, is frequent with those who have born many children. By this slipping down of the body of the womb F, into the vagina G, it presses on the neck of the bladder, or urethra. This is also apt to happen in the first months of pregnancy, from a degree of difficulty which the womb in its enlargement has in rising above the brim of the pelvis.

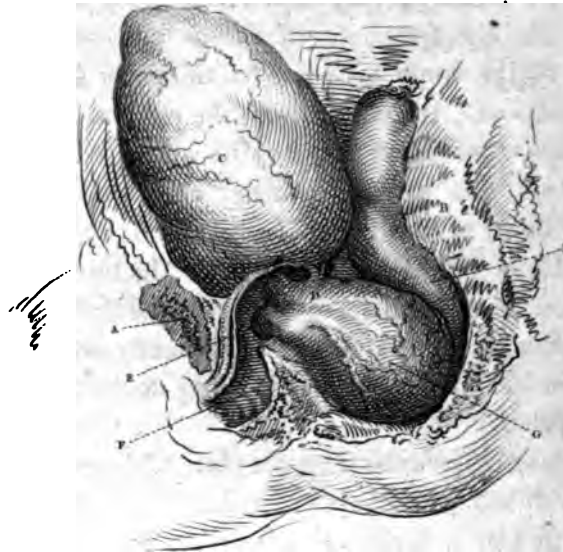
We may observe also from the place of the vagina G, that its diseases, its scirrhus hardening, its distention by the menses, will also compress the urethra and neck of the bladder.

The retroversion of the womb is the most formidable obstruction to the urethra. It is produced by distention of the bladder acting on the womb in a particular situation, and is the cause of suppression of the urine. When the womb in the third or fourth month of gestation has increased so much as to produce a degree of compression on the surrounding parts, and to rise above the brim, and shoot up into the abdomen, a distention of the bladder is apt to throw the fundus under the projection of the sacrum. We have to observe the connection betwixt the back and lower part of the vagina. By the distention of the bladder, the vagina is stretched, and the orifice of the

womb is raised, which throws back the fundus of the womb, so that this comes to be the situation of the parts.

*Second Plan of the Female Pelvis.*

*2d Plan of the Female Pelvis.*



A, the os pubis ; B, the sacrum ; C, the bladder of urine much distended, and rising above the pubis ; D, the connection betwixt the back part of the bladder and the upper part of the vagina, and through which the rising of this part of the bladder (in consequence of its distention) has drawn up the orifice of the womb, and thrown back the fundus. E, the orifice of the womb, which being raised and turned up, no longer presents so as to be felt by the finger in the vagina. It will be observed also, that the womb now lying across the pelvis, this lower part is forced against the neck of the urethra, so as to compress it, and cause total obstruction of urine. F, the vagina, which is stretched in consequence of the rising and turning up of the orifice

ice of the womb. G, the fundus of the womb enlarged and distended by impregnation, fallen back under the promontory of the sacrum, and compressing the rectum H.

Now, when the fundus of the womb is thrust back, and the orifice raised by the distention and consequent rising of the bladder, the natural and simple cure is to introduce the catheter, and draw off the urine. But should this not be done at first, then there being distention of the bladder, and pressure on the rectum, the abdominal muscles sympathize with these parts, so that bearing-down efforts are made, and the fundus of the womb is forced further down into the hollow of the sacrum, while the orifice is directed upward.

Were this distention to happen at any other time than just when the uterus is of such a size, that being thrown back, it catches under the sacrum, and does not rise again, no harm could follow.—I last year attended, with Mr. Cheyne senior, a woman afflicted with obstruction of urine, who died. I afterwards opened the body, where the womb being enlarged by disease, had produced much the same effect as if it had been enlarged by pregnancy, viz. obstruction of the urethra; for the body of the womb had fallen into the hollow of the sacrum, and had formed adhesions there with the rectum, while the orifice of the womb pressed forward upon the os pubis, so as to produce an obstruction of urine. The parts were otherwise diseased, but this was one cause of the obstinacy and fatal determination of the complaint.

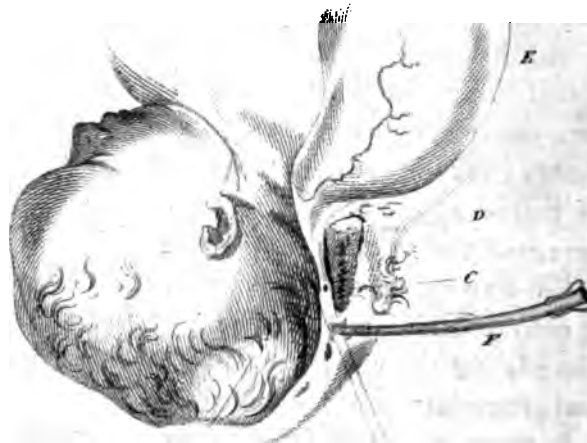
As we treat of those subjects only as connected with the urethra, we may observe, that sometimes the urethra

thra takes a course not round behind the os pubis simply, nor straight upwards, but curved backwards, so that the convexity of the catheter requires to be towards the sacrum, to allow the point to pass over the orifice of the womb, or perhaps the flexible, or the male catheter may be required.

The effect of the wedging of the child's head in a tedious labour, is to elongate and compress the urethra in a very particular manner. Many young men have felt the difficulty of introducing the catheter in this case. But it is a difficulty proceeding generally from ignorance, or inattention. I have never seen a case in which the compression was so great as to prevent the passing of the catheter. But often practitioners forget the direction which the urethra necessarily takes, when the child's head has sunk into the pelvis.

*Third Plan of the Female Parts.*

*3<sup>d</sup> Plan of Female Parts*



Thus, when in the second stage of the labour, the child's head A, has sunk into the pelvis, the urethra C, is pressed betwixt it and the os pubis D. The urine consequently collects in the bladder, and the bladder E, rises above the brim of the pelvis, and I have found it stretching to the scorbiculus cordis. There is danger from the distention of the bladder, and the labour-pains cease. Now the young surgeon or accoucheur, introduces the catheter in the usual way, in the position F, of course he finds great difficulty, and gives pain in the attempts. But after inserting the point of the catheter, he must incline its handle much towards the perineum, as in the inclinations of the dotted lines G, so that the point may glide up in the direction betwixt the child's head and the pelvis.

ORIFICIUM VAGINÆ. This is also named ORIFICIUM EXTERNUM, in opposition to the uterine orifice. I notice it under the head of the external parts, because we have to speak of the parts which surround the orifice as the hymen.

The orifice of the vagina of the human female is abridged by the hymen, which is a peculiar membrane. It is of a semilunar form, and sometimes surrounds the lower part of the orifice of the vagina;—commonly it surrounds only the lower half of the circle, though it would seem to vary considerably in shape, place, and strength. It has been found surrounding the whole circle of the orifice, leaving only a small hole in the centre, or upper part; or it is described as perforated with lesser holes, allowing the evacuation of the menstrual blood. In other cases, it has been found a complete circle, preventing



## CHAP. II.

## OF THE PARTS CONTAINED WITHIN THE FEMALE PELVIS.

**T**HESE parts are the bladder of urine, the vagina, the womb, the ovaria. We shall consider them under distinct sections.

## SECTION I.

## OF THE BLADDER OF URINE.

As the coats of the bladder of urine in woman do not vary from those of the male bladder, we have under this head only to notice the peculiarities in its relative situation. It is seated behind the os pubis, and betwixt it and the womb; and on its lower part it is attached to the vagina; upon the neck of the bladder, or the beginning of the urethra, there is not a body like the prostate gland; and, as we have seen, the urethra is short, wide, and straight, and simple in its use.

Women are not subject to calculi, and the operation for the stone is rare in them; for, as already observed, when the nucleus is formed, or when a stone slips down from the pelvis of the kidney, it passes from the bladder with much greater facility than in the male parts. The urethra of itself has been known to dilate  
so,

so, as to allow very large stones to pass, or it has been artificially dilated. Indeed the old operation for lithotomy, was rudely to dilate, or rather tear, the urethra, and the modern operation is simply to thrust the gorget along the grooved staff, so as to lay open the side of the urethra and neck of the bladder, by an incision above the vagina. Sometimes nature has effected her own relief by the stone working from the neck of the bladder into the vagina.

A woman had for a very long period suffered great distress, not only the ardor urinæ, frequent desire to make urine, with the urine turbid and bloody, and with all the usual symptoms of stone violently aggravated; but she was delicate and timorous, and concealed her distress until the urine had run for some time by the vagina. After she had been exhausted by long suffering, her friends insisted that she should allow an examination, when a stone was found partly in the bladder, with one of the rough ends projecting into the vagina. The opening was enlarged, and the stone extracted.

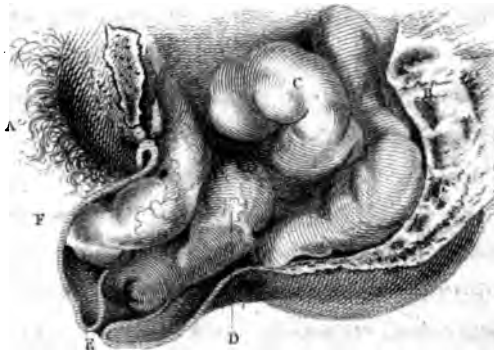
We must, in all cases, recollect the connection of the upper part of the vagina and orifice of the womb, with the back part of the bladder. We have seen its effect in producing retroversio uteri. We must also attend to this connection, as tending to the displacement of the bladder in the procedentia uteri. The uterus sinking into the vagina, and the upper part of the vagina being at the same time reflected into the lower part, pulls down the bladder with it, and when (the disease increasing) the womb covered by the vagina comes to hang from the external parts, it has happened that the bladder has sunk down and lain

Q 2

upon

upon the fore-part of the tumor, but of course within the everted vagina.

*1<sup>st</sup> Plan*  
*Section showing the effect of Prolapsus on the Bladder.*



Thus, by comparing this fourth plan with the first of the female pelvis, we may judge of the nature of this displacement of the womb, and its effects on the bladder of urine.

A, the os pubis; B, the sacrum; C, the intestines come into the situation of the womb; D, the uterus fallen down, and carrying the vagina before it; E, the vagina still covering the womb, but the orifice of the womb appearing, which is generally distorted and irregular; F, the bladder, which, from its attachment to the fore-part of the vagina, has been dragged down, but is now within the vagina.

In such displacement of the bladder, the urethra becomes distorted from its natural direction, there is an obstruction of urine, and the catheter is with great difficulty introduced. We shall, perhaps, have to  
turn

turn the handle of the catheter in various directions after introducing the point, and by chance get it introduced at last.

## S E C T. II.

## OF THE VAGINA ; OF ITS SHAPE, CONNECTIONS, ETC.

THE vagina is a tube stretching from the external orifice to the orifice of the womb. Its orifice is bounded below by the fourchette ; above by the arch of the pubis ; and directly over it, or sometimes within it, is the orifice of the urethra ; below, are the carunculæ myrtiformes. It is surrounded by fasciculi of fibres, which are called the sphincter muscle. The canal of the vagina is of a conical form. At the outer orifice it is constricted by the sphincter muscle ; but it is wider within, and where it receives the orifice of the womb. It may be distended to almost any degree, but naturally its sides, by their own elasticity, or the contraction of the surrounding fibres, or the pressure of the surrounding parts, are in contact.

In the natural state, the orifices of the vagina and womb, are but three or four inches distant, often only two ; and sometimes, where there is a degree of relaxation, they are nearly in contact. In the first months of pregnancy, the orifice of the womb is kept down by the degree of difficulty the body of the womb has in shooting up from the brim of the pelvis. But the gravid uterus rising above the pelvis in the latter months, draws up the orifice of the womb, and stretches the vagina.

The vagina bends gently round the pubis as it were, or follows the axis of the pelvis; and as the interior of two circles cut off by the same radii is the shorter, the vagina is longer behind than before.



And thus (*in this fifth plan*) the fore-part of the vagina A, is shorter than the back part B. We may observe from this plan also, that the orifice of the womb C, projects as it were into the vagina, so that the finger touches the os tincæ, and chiefly its anterior lip, without reaching the upper part of the vagina.

The vagina takes its curve nearly in the centre of the pelvis; it is of necessity attached by cellular substance to the rectum and bladder. The urethra, as we have said, opens above the orifice, and that canal is attached to the vagina in its whole length; and the neck of the bladder is attached to the upper part. In consequence of this natural connection, disease of the vagina sometimes throws the whole parts, the rectum, vagina, and bladder, into one fistulous ulcer.

The vagina has three coats; that is to say, it has the inner coat, or surface, a few muscular fibres, and around it a condensation of the surrounding cellular membrane, which may be considered as the third coat.

The internal, or villous coat, is a reflexure of the delicate covering of the external parts. It is of larger extent, or longer than the others; and is therefore tucked up into rugæ, which run across the vagina. They are more remarkable on the fore and back part of the vagina; they are less in married women, and considerably obliterated by repeated labours.

To supply a viscid secretion for the defence of this surface, mucous glands are numerous, but irregularly scattered over it, and they are particularly numerous at the orifice.

The muscular coat is not very strong, nor are the fibres distinct, from which some have suspected their existence, alleging, that there is here only condensed cellular membrane, and that the contraction of the vagina is the effect of mere elasticity. I observe so great a profusion of venous vascularity, that I presume the vagina suffers an inflation of its coats, and consequently contraction from an afflux of blood to it. The muscular fibres are, however, as we have said, gathered into fasciculi near the orifice, so as to be distinctly visible.

The firmness and stricture of the vagina support the womb; the dilatation of the vagina, the relaxation which old age, and frequent labours produce, occasion the falling down of the womb. It is a disease almost peculiar to those who have borne many children, to the old, weak, and relaxed, and to those who are subject to the fluor albus; every flux from the womb,

or discharge from the vagina, having a remarkable effect in relaxing the parts.

This, from the nature of the parts, must be an increasing disease; for no sooner has the womb fallen down into the vagina, than it becomes a source of irritation, excites a bearing-down pain-like tenesmus, an uneasy sensation, a desire to make urine, and an obstruction of urine; all which is explained by the connection of the parts. The womb lodging in the vagina dilates the orifice, and presses long on the perineum, at last it is entirely forced out, and the prolapsus uteri becomes the procedentia uteri: it is in truth a hernia of the womb.

The third, and outer coat, as we have said, is formed of the cellular membrane, by which it is connected with the surrounding parts; but the peritoncum comes down upon the upper part of the vagina. This is the reason why a portion of the intestine, when it slips down betwixt the vagina and rectum, forms a kind of hernial tumor in the vagina, and why the water of ascites has pushed down the back of the vagina, so as to make a bag capable of being punctured to draw off the water.

For the greater space, however, the outer cellular coat of the vagina connects it with the urethra on the fore-part, and with the rectum behind. From which close connection of parts, we see the consequence of the delay of the child's head in the second stage of labour, that the head lies violently distending, and compressing the parts, while the woman, exhausted by the previous stage, is unable to complete the delivery. From violent inflammation, with a deficiency

of secretion there are

below; THE CERVIX, which is the narrow neck; and  
the



the *os TINCÆ*, or orifice formed of the bulging lips, which project into the vagina, of course that part over which the inner membrane of the vagina is reflected. We distinguish also the two surfaces, for the womb is of a flattened form. The anterior surface of the body of the womb is convex; but the posterior surface is considerably more so, and even during gestation it keeps this relative figure.

The whole size of the uterus is about three inches in length, and two in breadth, but there is a very great variety in this respect, from age, the effect of pregnancies, and other causes. When, in its usual situation and relations, the fundus is on a level with the brim of the pelvis, or a very little below it. In the *foetus*, the womb is like the bladder, considerably above the brim of the pelvis; but, in a few weeks the pelvis enlarging, it sinks deeper, and soon assumes the same situation as in the adult.

**FALOPÉAN TUBES.** From the lateral obtuse angles formed betwixt the fundus and the body of the uterus, the Falopéan tubes are continued. These tubes may almost be considered as a continuation of the uterus, did not we find them so very distinct in their substance. They are about three inches in length, take a tortuous course, and their extremities have an unequal fringed termination, which is called the *FIMBRIÆ* \*. Their canal is very small towards the uterus, but enlarges, and is patulous towards the extremities. These canals are the communications by which the ovum formed in the ovarium is carried down into the womb.

\* *Morsus diaboli.*

**LIGAMENTS OF THE UTERUS.** To support the uterus from sinking too deep into the pelvis, and to steady it, and direct it in its ascent during pregnancy, anatomists have generally assigned as the use of the ligaments. But whatever good they may do in the latter operation, they are certainly unfit for the former.

There are four ligaments of the uterus.

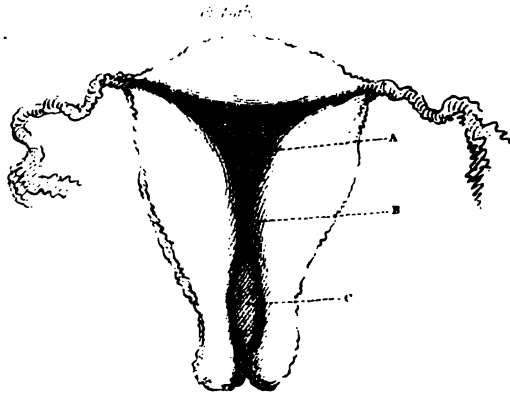
The **BROAD LIGAMENT** of the uterus is formed of the peritoneum; for this membrane passing down before the rectum, and ascending again, and covering the neck, body, and fundus of the womb, descends on the fore-part, so as to reach the vagina before it rises over the bladder. Thus it invests the womb as it does the abdominal viscera. This investing of the womb with the peritoneum is indeed a provision for its becoming an abdominal viscus, for in pregnancy it rises out of the pelvis; and, being distended before the bowels, assumes in every respect that relation to the peritoneum which they have.

As the womb then is included betwixt the duplicature of the peritoneum, it is this peritoneal coat, which being continued off laterally, forms the broad ligament of the womb. This duplicature of the peritoneum being a thin expansion of it, has sometimes had the name of *ALÆ VESPERTILIONIS*: It is in truth like a mesentery to the womb and Fallopean tubes, and serves equally to support and convey the vessels to them. The womb and the two ligaments make a complete partition running across the pelvis.

From the side of the uterus, a little below, and before the going off of the Fallopean tubes, the **ROUND LIGAMENTS** arise. I consider these ropes as ligaments,

ments, but they are totally unlike any common ligament. They seem intended to give the due inclination forward, and to direct the uterus in its ascent in pregnancy, and accordingly they are not merely condensed and unelastic cellular membrane; but, on the contrary, they are composed of fibres, with an intermixture of blood-vessels, so that whilst they keep a degree of tension on the uterus, they yield and grow not only in length, but in thickness and strength, as the uterus ascends in the advanced pregnancy: they pass through the abdominal ring, and are attached to the cellular membrane of the top of the thigh. In the gravid uterus, both the broad and the round ligaments considerably alter their position, appearing to rise lower, and more forward from the womb than in the unimpregnated state. This is in consequence of the greater increase of the fundus of the womb, in proportion to the lower part of it.

## OF THE CAVITY OF THE UTERUS.



The cavity of the uterus is properly confined to the fundus and body; and takes a triangular figure. In the

the cervex, it is more like a canal, and differs essentially from the proper cavity. A, *the cavity of the uterus*; B, *the continued cavity*, where it is very narrow towards the cervix. C, *the canal of the cervix*, where it has an enlargement like a sinus. The Fallopean tubes going off from the cavity of the uterus. These angles of the cavity admit no more than a hog's bristle. The third angle, towards the neck, is, of course, considerably larger. The proper triangular cavity of the uterus is lined with a peculiar soft and delicate membrane; it is very vascular, and the vessels either open on the surface naturally, or bursting out from time to time, pour out the menstrual blood. The canal of the cervix shows a very different surface. We observe a prominent longitudinal line on the fore and back part of it, from which oblique and transverse rugæ go out. The surface is firmer and callous, and less vascular. Betwixt the rugæ there are lacunæ, which throw out a mucilaginous fluid; and towards the orifice we see these larger, and sometimes distinct glandular bodies.

This peculiar shape of the cavity of the womb, and the hardness and small degree of vascularity of the lower part, is of the most essential importance. The upper part, the proper cavity of the womb, is prepared for the reception and immediate adhesion of the ovum, when it shall have descended through the Fallopean tube; but the long callous cervex is provided, that there may be no adhesion to the lower part of the womb, and that the placenta may not form over the orifice of the womb, for if it should, the most dangerous

ous kind of flooding takes place on the approach of labour from the opening of the orifice, and the tearing open of the adhesions of the placenta, before the child can be delivered. The length of the cervix, and the glandular structure of the orifice is also of much importance in sealing up the cavity of the womb after conception, that there may be no longer communication with the vagina ; for this purpose, a viscid tenacious mucus is poured out ; but, on the approach of labour, with the softening and relaxation of all the soft parts, this adhesion and gluing up of the orifice is dissolved, and a more fluid secretion is poured out.

From the cavity of the womb the MENSTRUAL BLOOD is discharged at certain periods, from the time of puberty to the approach of old age, when the system is no longer capable of giving nourishment to the fœtus. We shall presently find, that the subserviency of menstruation merely to the preparation of the surface of the womb for the reception of the fœtus, though it be a principal, is by no means the sole end of this periodical discharge.

It was long disputed from what source the menstrual discharge flowed. Some affirmed, that it must flow from the vagina, and not from the womb, because it flowed sometimes during gestation. This is a fact which cannot be denied. I have attended a patient who menstruated during the entire period, or to the eighth month ; and I have often observed ladies, to menstruate at the first period after conception. On the other hand, we have every proof of the discharge being

being from the orifice of the womb. For instance, some have observed on dissection of the parts of women dying during the flow of menses, that blood was effused under the delicate membrane of the cavity of the womb. The vessels there have been observed particularly turgid, or the whole surface of the proper cavity, and especially the fundus, spotted with bloody effusions. More particular observation has shewn, not only the mark of blood poured out from the inner surface, but that the whole substance of the womb was become thick, soft, and vascular\*; and M. Littre affirms, that in the body of a woman who had died during menstruation, and with a conception in the Fallo-  
pean tube, he found a layer of red-coagulated blood; upon removing which, he saw a number of small foramina which admitted bristles †.

But the best and least equivocal proof is, that which has been repeatedly observed in the inversion of the womb, when the inner surface has been turned out after labour, and has remained thus inverted, and protruding from the external parts, for then the menstrual blood has been seen to distil from the surface of the cavity of the uterus.

#### OF THE BLOOD-VESSELS OF THE WOMB.

These are four large arteries which supply the system of the womb, and four large veins which return the blood.

\* The authorities upon this subject are Spigelius, Morgagni, M. Littre, Mouriceaux, Winslow, Sympson.

† This might have been an early abortion, or perhaps the decidua which it is said is sometimes formed at the menstrual period.

The

The SPERMATIC ARTERIES come down from the aorta itself, or from the renal or capsular arteries. The spermatic artery taking a waving direction, becomes tortuous in a most remarkable degree as it approaches the uterus, it is distributed to the Fallopean tube, the ovarium, but chiefly to the body and fundus of the uterus, where it forms remarkable anastomoses with the artery of the other side.

The LOWER ARTERY—the UTERINE ARTERY, comes in general from the hypogastric artery, takes also a serpentine course, and is distributed to the vagina, and the lower part of the uterus, and inosculates largely with the other vessels, both in the uterus, and by particular branches on the side of the uterus.

In the first place, it appears, that this copious supply of vessels to the uterus, from four different sources, is a provision that the womb and secundines shall not by any accident of position, or by the progress of labour, and the consequent compression of one or both the lower vessels, be deprived of their due supply of blood. Again, their tortuous forms give proof of their occasional greater activity, that they admit of a peculiar and local action during menstruation, and that the blood will move more languidly when the stimulus of the womb has ceased. It is also a provision for the growth and increase of the womb, and the supply of nourishment to the ovum. And that an increased activity in a part must be supplied by a more tortuous form, as well as an enlargement of the calibre of the vessels, is in a particular manner illustrated by the change which takes place in these vessels during pregnancy. For they become in a much more remarkable degree tortuous and enlarged.

The

The substance of the uterus is said to be spongy and compact, which, though it is a seeming contradiction in words, does yet really convey an idea of the effects of its copious intertexture of vessels. Some have said, (as Moriceau,) that by pregnancy the womb is distended, and grows thinner: others, that it grows thicker, as Daventer: and others again, as Smellie, assert, that it continues of its natural thickness. These assertions are none of them perfectly correct: for the womb is not distended by the growth or the foetus and membranes, but grows with them. Again, that the substance of the womb grows in a remarkable degree, is true, but still when distended by the waters in the last months of pregnancy, its walls are thinner than in the unimpregnated state. Thus, when it has been cut in the living body, upon the approach of labour, in the Cæsarean section, I have observed it, not more than a quarter of an inch in thickness, even at the part to which the placenta adhered. When I have dissected the womb after a tedious labour, the waters discharged, but the head wedged in the pelvis, I have found it considerably thicker. And, lastly, in the full contraction of the womb, after expelling the foetus and placenta, (for example, in rupture of the womb, where the child and placenta had been forced amongst the bowels, and the woman soon after died,) I found the walls of the womb about three quarters of an inch in thickness.



## SECTION IV.

## OF THE OVARIA.

THE OVARIA, are two oval bodies, which are suspended in the broad ligament behind, and a little below the Fallopean tubes: while they have an oval figure, they are somewhat flattened. By cutting out the ovaria, the animal loses the power of conceiving, and desire is extinguished; they, therefore, bestow what is essential to generation upon the part of the female. In vague speculations on the subject of generation, they were supposed to prepare a female semen! but more particular examination demonstrates, that they consist of vesicles, which are ova; but how far incomplete, or in what essential circumstance requiring the approach of the male, is not determined.

When we hold the section of the ovarium betwixt the eye and the light, we see a great many pellucid vesicles; and if we examine the ovarium of an animal killed in full health, and particularly in the season, we shall observe these ova to be in all varieties of states of preparation for impregnation. Some small and pellucid, and yet only discernable in the thick outer coat, by having a degree of greater transparency; others, which have taken a slight tinge of bloody colour from vessels striking into them; and if the section be made after a minute injection, the vesicles will be seen coloured in the proportion of their maturity; some without a speck of colour; others tinged;

tinged ; one or two loaded with injection ; and some vascular, and particularly prominent.

In very young girls, the substance of the ovarium is whitish, and very soft ; the surrounding membrane is thick ; and the round corpuscles scarcely discernable ; and no irregularities, nor any of those bodies called corpora lutea, are to be seen on the surface. But as the girl advances in years, the little vesicles begin to appear, and when about ten years of age, or just before menstruation, the ovarium is full of ova of various sizes, and some of them more matured, and forming an eminence upon the surface. In the adult woman, the substance of the ovarium, which appeared as an uniform homogeneous mass in the foetus, is become a cellular and vascular bed, giving nourishment to those numerous vessels or ova. Before impregnation can take place, there must be a certain state of preparation of the ovaria, without which the approach of the male effects no change in the uterine system. The lower animals having their seasons, and these seasons being a state of preparation for the male, impregnation follows the copulation with much certainty : but, in woman, such a periodical revolution in their system, and instinctive desires, would but ill accord with that superiority in attributes of the mind, which distinguish us in the scale of beings. But women also suffer such an occasional excitement in the uterine system, though unaccompanied with desires, which preserves the womb in a state of preparation for the reception of the ovum, and the ovaria in a state of preparation for impregnation. This is the effect of menstruation.

## OF PUBERTY.

AUTHORS have long, with many expressions of surprise, laboured to assign a cause, or frame a theory for the explanation of those changes which we observe in woman at the age of puberty: and generally, in their theories, they have connected with these changes the monthly and periodical discharges of blood from the uterus, which commences with puberty. These theories have been founded in general, on principles remote from the laws of a living system. At this period of puberty, the whole frame is expanded into the fullness of feminine beauty; the breasts rapidly increase, and are matured; the parts of generation are enlarged; the hair of the pubis grows, and the menses flow. In explanation of these changes, theoretical conjectures after this model have been entertained. “About this time the growth of the body begins considerably to diminish, and the blood finding easy admittance into the completed viscera is prepared in greater quantity, the appetite being now very sharp in both sexes, a plethora consequently follows. In the male it vents itself frequently by the nose, from the exhaling vessels of the pituitary membrane being dilated, &c.; and now the semen first begins to be secreted, and the beard to grow. But, in the female, the same plethora finds a more easy vent downwards, being that way directed, partly by the weight of the blood itself to the uterine vessels, now much enlarged, of a soft fleecy fabric, seated in a loose hollow part, with a great deal of cellular fabric interspersed, which is very yielding and succulent,

at, as we observe in the womb: for these vessels, the vessels being easily distensible, the blood finds a more easy passage through the very soft fleecy exhaling vessels which open into the cavity of the uterus, as being there less resisted than in its return by the veins, or in taking a course through any other part; because, in females, we observe the arteries of the head are both smaller, in proportion, and of a more firm resisting texture. The return of the same is, therefore, more slow, both because the flexures of the arteries, from the increased afflux of the blood, become more serpentine and fit for retarding the blood's motion \*, and likewise, because it now returns with difficulty through the veins. The blood is therefore first collected in the vessels of the uterus; next, it is accumulated in the arteries of the loins, and the aorta itself, which urging on a new torrent of blood, augments the force so far as to discharge the red blood into the ferous vessels, which at first transmit an increased quantity of warm mucus, afterwards a redish coloured serum, and by suffering a greater distension, they at last emit the red blood itself. The same greater impulse of blood determined to the genitals, drives out the hitherto latent hairs, increases the bulk of the clitoris, dilates the cavernous plexus of the vagina, and whets the female appetite to venery, &c."

We cannot give implicit trust to such speculation, we cannot believe in this plethora, produced by the diminished growth of the limbs; neither can we be-

\* I have shown that the tortuous arteries always form a provision for the occasional increase of the action and acceleration of the blood.

lieve that congestion and plenitude is produced in the female system, from the deficiency of perspiration, from their more lax and weaker solids compared with man, from their indolent and sedentary life: for facts are in direct contradiction. The growth and completed function of parts at this particular age, is not to be explained by any theory so partially applicable; during almost every period of life, there are similar changes taking place in some one part of the body. Parts lie dormant, and are stationary in their growth, which at a particular and stated age of the animal, enlarge and develope themselves by a new and invigorated action. Observe how different the proportions of the foetus are from those of the adult. We see nature careful to perfect certain parts, as the head and liver, at an early period. We see during early childhood how the parts shoot out, and evolve in due proportion. We see parts which were large in the foetus lose their preponderance: we see others, which served some purpose in the foetal system, gradually shrink and disappear, because they have no longer the stimulus to action in the circle of connections which take place in the adult system. We find other parts, as the teeth, for example, lying long within the jaw, instead of proceeding with a gradual and continual enlargement, suddenly rising at certain stated periods from their embryotic state, and enlarging and pushing up through the gums, when it becomes fit that the child should take more solid food than the mother's milk. So the second set of teeth, in a more particular manner, lie quite stationary in their growth within their little sacs, yet quickly, at stated periods, they increase, the enamel

mel is formed, and they rise above the gum. There is an infinite number of such changes depending upon the same laws of the oeconomy, and not different from those which controul the growth, and direct the shape of parts. They depend upon certain laws of the constitution, which give an excitement to certain parts, at stated periods, and which no theory partially applicable will explain. There is a series in which the parts of an animal body are matured, and a succession in which the functions are brought to maturity: and in the female constitution, there are laws determining an action upon the womb and breasts, and all parts subservient to conception and the nourishment of a foetus; at that period when the woman is arrived at the age fit to take upon her the part of a mother.

## OF MENSTRUATION.

UNDER this head, I shall confine myself to such a general view of the subject, as is necessarily connected with the peculiar functions we are now endeavouring to comprehend.

Menstruation is a state of preparation for conception. When, therefore, the menses flow at the natural periods, and in due quantity, it is a sign that the woman may conceive, and that her system is fit for the support and nourishment of a child. It is a general affection of the system, which has a tendency to relieve itself by a topical action, by the excited action of the uterine system; and this excitement of the uterine system is the end which nature is accom-

plishing. To explain this, I may be allowed to take a short preliminary view : each particular organ or viscus, whilst it has its connections with the general system, is, in truth, a system within itself, having its peculiar functions, sympathies, and even vascular action, in a certain degree, independently. Were not this, in some measure the case, we should see no local disease or topical action ; and no vascular action could be for a moment stationary and confined to one part. The body would, indeed, be then only one great hydraulic machine. But while the several parts have the property of being excited separately to an accelerated action, they are actuated by remote sympathies, and by these sympathies and relations, is the whole system in a great measure supported.

Before menstruation commences, there is a preceding indisposition, and symptoms indicating a constitutional affection. And these complaints are usually more severe in the first, than in the subsequent periods. The general revolution in the system begins to accumulate its action towards the womb, and those symptoms usually accompanying uterine irritation, show how far it is affected, and in a little time the menses flow. Now, I conceive, the flow of the menstrual blood, to be not the end which nature is here labouring to accomplish, but the means of allaying the excited state of the uterine system after the object is accomplished. It is not the discharge of a few ounces of blood which relieves the system ; for drawing blood simply will not do it ; but it is the excited action of the uterine system which relieves the general distress, and that topical action has full relief in the menstrual discharge.

discharge. General and topical plethora are terms which have been of great service in explaining this periodical change in the female system, but the state of mere fullness, has little effect either on the constitutional or topical change. Even in the exhausted and debilitated state of the system, when menstruation ceases from the want of energy and power in the vascular system, still there remain the same laws governing the sympathies, and relations of the several parts; and although they are feebly and imperfectly excited, they give rise to accumulated distress at the period in which the menses should flow.

There is more general distress at puberty, and when the menses first flow; but afterwards, when the periodical action and discharge is established, there is little or no previous indisposition.

With regard to vicarious hæmorrhagy from remote parts of the body, some, whose opinion I greatly value, do not consider them as deviations of the menses. At all events, from what I have seen of such hæmorrhagies (tumors, for example, discharging blood at the menstrual periods), I would observe, that there is an excitement, throbbing, and distension, previous to the discharge of blood, which confirms me in the notion of the necessity of a counter excitement and action, as well as the discharge of blood, being necessary to make a derivation from the uterine vessels. It is by dissection alone that we can form an established opinion regarding the final use of the periodical return of the menses.

By dissection we come to the knowledge of the most essential facts. In the first place it is found, that  
the .



the ovaria, and their vessels, partaking of the general excitement of the spermatic arteries, are enlarged, full of blood, and with every sign of increased action. We find also, that the ovaria are matured and brought to *pubesce*, and almost to start from their investing membranes. Again, when we attend to the womb, we find, that these are marks of its whole vascular system being roused to action. It has become laxer in its texture, and there is a change similar to what takes place in the first stage of pregnancy, but less in degree. The vessels on the inner surface of the womb have been influenced by an action similar to inflammation, and it is asserted, that even the decidua is sometimes formed. Thus, while the ovaria are ripened to that degree of maturity, which prepares them for impregnation, the surface of the womb, and its whole vascular system, is preserved in a state of preparation for the adhesion of the ovum, when it shall have descended through the Fallopan tube. I conclude that in considering this subject of menstruation, the mere circumstance of the discharge of blood has been too much attended to, while these other more essential circumstances have been neglected.

It is not easy to determine, says Haller, either in this, or in any other spontaneous hæmorrhagy, from what kind of vessels the blood flows. From the circumstance of the hæmorrhoidal discharge, which certainly is from veins, and from the lochia, which is generally supposed to be a discharge from the venous sinuses of the womb after delivery, we have the argument of analogy, that in menstruation also it is a venous discharge. This opinion is further confirmed

from stagnant blood being found in the uterine veins of women dying during the flow of the menses, and orifices being observed larger than could well be supposed to be the extremities of arteries.

I would say, that it is little probable that spontaneous hæmorrhagy proceeds from the rupture of the extreme arteries, because it is the activity of the arteries which causes the hæmorrhagy; and because this activity is the exertion of a muscular force, and the exertion of a muscular fibre never is such as to tear the fibre itself. On the other hand, we observe that it is the necessary consequence of an increase of the action of arteries, that the corresponding veins dilate, and seem to suffer a force of distension proportioned to their increased activity. We must not forget that many are of opinion, that the menstrual blood flows from the exhaling arteries. This opinion must rest upon argument, and not facts, unless the assertion of Razuw be taken as proof, that he could distinguish their mouths; or that of Mebomius, who said he introduced bristles into them. That anatomists have introduced bristles into pores, or foramina, it would be ungracious to doubt, but that these were the orifices of exhaling arteries, is difficult to believe. I rather imagine, that there is a provision for this evacuation in pores, or foramina, in the extreme veins on the vascular inner surface of the womb.

From the consideration of the cause of menstruation, as I have conceived it, from the symptoms which proceed and accompany it, and from the effect attributable to the menstrual action on the uterine system, we cannot consider it as a mere evacuation of blood,  
but

but rather as of the nature of a critical discharge relieving the symptoms which preceded it. With regard to the opinion of its being a secretion, we must first know accurately what is meant by the term. If those who suppose the menstrual blood a secretion mean only, that the blood is occasionally changed by the action of the vessels of the womb. I should willingly acquiesce in their opinion, for even during the bleeding from the arm by the lancet, or from a common wound, the blood is altered in the space of the few minutes during which it flows; and before the final stopping of a common hæmorrhagy, there is a change in the properties of the effused blood.

When there is an unusual source of irritation in the womb, added to the natural and periodical excitement of the parts, the menses become more profuse, they last for a longer period, the time of their intermission is shortened, and, in the end, from some diseases of the womb, there is a perpetual oozing of blood, which debilitates the woman, and destroys her constitution, or there is sudden and profuse discharge with coagula, unlike the usual evacuation.

#### OF THE CHANGE PRODUCED BY THE UNION OF THE SEXES.

IN considering those changes produced on the ovaria and womb by impregnation, we must have recourse to analogy in the first instance. By attending to the changes produced in vegetables, and the lower animals, we may be enabled to comprehend some of the changes

changes in the female organs consequent upon conception, and which we might not otherwise be enabled to understand.

We see that vegetables propagate their branches in every respect like the parent trunk. We see in the autumn the bud lodged in the axilla of the leaf, and observe it pass through the winter in a kind of dormant state; but when it is influenced by the returning heat of the spring, it shoots out to full maturity. This growth is a natural power of propagation, and increase, marked by no very peculiar circumstance, yet bearing a strong analogy to the production of the seed.

In the formation of the fruit of the same tree, we see a more complicated provision for the propagation of the plant. We find that although the seed appears to be formed by the natural growth of the part like the bud, yet before it becomes prolific, and capable of growing, and arriving at maturity, it must be influenced by circumstances similar to the union of the sexes of animals; that its power of reproduction depends upon the reciprocal action betwixt the parts of the same plant, or by the approximation of male and female plants.

Between the formation, maturity, and impregnation of the seed of plants, and those of the ova of animals, there is a close analogy. The seed is formed and matured while attached to the parent plant; but the vessels of the plant having completed this operation, shrink from their connections with the seed, leaving it with its little system of vessels complete, and with a kind of imperfect life, which may be considered as analogous to a dormant state. This imperfect life, or  
perhaps

perhaps a state merely capable of being excited into life and motion, continues for the winter season, or for a longer period.

The flower of plants solicits the fluids to the seed, as the influence of the leaf cherishes the bud in the axilla. The pulp of the fruit is probably a provision of the same kind, or when it has fallen, to lay the foundation, by its decay, of a soil suited to the tender plant.

In the seed itself, we have much to admire. We find it incased in a strong husk, or shell, which is in general provided with a porous part ready to imbibe the moisture of the ground. In the nut within the outer shell, there is a soft spongy substance, which, receiving the moisture, swells and bursts up the shell, and relieves the seed. The kernel of the nut is then like a common seed, it has begun to vegetate, and these are the parts which form the system of its œconomy. The principal part of the seed consists of albuminous matter for the supply of the nourishment to the embryo plant, so as to prolong its shoots, and to send down its roots into the earth. The little embryo plant lies complete in all its parts, betwixt the lobes of albuminous matter, in a state of torpor, or in which the operation of the living principle is suspended. From the embryo plant there extends into the albuminous matter of the seed vessels, or tubes, inactive, but ready on the supply of heat and moisture, to absorb the nutritious matter of the albumen, and minister to the increase of the embryo plant.

Now the root of the little plant sprouts from the seed, and has a tendency to strike into the ground,  
and

and the bud rises to the surface towards the light, and the influence of the atmosphere.

We see in this instance, that the operation of the system of tubes of the embryo plant in the albumen was merely suspended, that upon the seed being put into the ground, the heat and moisture promote the germination, by driving the nutritious matter of the albuments to the embryo plant. In the first stage of this change, the matter absorbed by the vessels of the albumen supply that nourishment, which afterwards is conveyed from the root striking into the earth, and from the leaves absorbing from the atmosphere. And when the roots have struck into the earth, and the first leaves rise upon the surface, the lobes of the albumen are exhausted and fade, or rise up in form of leaves, still cherishing the tender plant.

When we come accurately to examine the situation of the embryo in oviparous animals, we shall find the same provision for the nourishment and growth of the young animals, independent of external circumstances, nourishment prepared for it until it shall be enabled to gain strength to feed itself.

The manner in which an egg is formed is this: The yolk, with its delicate membranes, are formed in the ovarium of the hen. The ovarium is placed on the back-bone, innumerable yolks are seen gradually formed, and successively increasing in size. When they are matured, they are of the full size we see them in the perfect egg; they are surrounded with a delicate web of membranes, extremely vascular, which bursts when they are mature and impregnated, and then they fall into, or are grasped by the infundibulum, or what  
answers

answers to the Fallopean tubes in woman and quadrupeds. While yet in the egg-bed, the cicatricula, or embryo, is seen to be included in its membranes, upon the surface, or in the membrane of the yolk; as the yolk, and the imbibed cicatricula, passes through the uterus, the yolk, in a most curious way, has the addition of the other part of the egg. The uterus of a bird is not like that of other quadrupeds or viviparous animals, simply for the reception of the ovum; but it is long and convoluted like the intestines. And the yolk, as it drops into the upper part of it, collects as it passes alongst the uterus, the white of the egg, which is a secretion from it. As it proceeds downwards, it receives the membranes of the white, and before it is excluded, it is coated with the shell to preserve it from injury when it shall be dropt from the hen. In the fully formed and incubated egg this is the situation of the parts. Under the shell is a membrane which invests the whole parts, but leaves a space containing air in the greater end betwixt it and the shell. Within this membrane the glarry white of the egg is contained, and within the white or albuminous matter is the yolk. Under the membrane of the yolk, there is a small spot of a lighter yellow than the yolk. This, upon examination is found to be a vessicle, and within it we see a lesser circle formed by an inner vessicle: this is cicatricula, and within this the rudiments of the chick are contained. We may observe, that the yolk is specifically lighter than the white; again, it is fixed, towards the two extremities of the egg to the albumen, or white, by the chalaza. These are like twisted cords, which arise from the yolk, and expand in the white,

so that they take a pretty firm hold on its tenacious substance. These chalaza are not fixed to the yolk in its axis, but to the side, so that the buoyancy of the yolk keeps it revolving as the egg is turned, so as always to present the cicatricula to the upper part of the egg, in whatever way it is placed; consequently it is always contiguous to the body of the hen, so as immediately to receive the influence of the maternal heat. By incubation, the principle of life in the chick and its membranes is roused, and the first perceptible change appears in little bloody streaks, which, running together, form a circle of vessels, and, which, are seen to terminate in the umbilicus of the chick.

This vascular circle, the most beautiful appearance of any in the œconomy of animals, ought to be particularly explained. In Mr. Hunter's book treating of the blood, there is a plate which represents the embryo of the chick in the incubated egg, at three different stages of its formation, beginning with the earliest visible appearance of distinct organization.—The preparations from which these figures are taken, form part of a complete series contained in Mr. Hunter's collection of comparative anatomy.—They are meant to illustrate two positions laid down in his work, viz. that the blood is formed before the vessels, and when coagulated, the vessels appear to rise; that when new vessels are produced in a part they are not always elongations from the original ones, but vessels newly formed, which afterwards open a communication with the original.

This to me seems an idea founded on a very limited view of the state of the parts. We must recollect that



this is not the formation of new parts or new vessels. The embryo is in that state of which I have endeavoured to convey an idea, by the term dormant; possessing that degree of life which is to be renewed by incubation, or artificial heat, but which will last a great length of time, and, like the germ in plants, be brought to vegetate only in particular circumstances. The tract of these vessels is laid in the original conformation of the embryo and surrounding membranes, they are now merely called into action, and we see only the effect of this action. We see red blood formed; we know that the redness of the blood is derived from the membranes, and matter which surround the embryo, and that it is conveyed to the chick or embryo. Before we allow ourselves to conjecture what is the first motion in the circle of actions which now take place, we must consider whether it be not more likely that the first action of these vessels is in absorption; that is, an absorption in the extremities of these vessels, or is there first, an action of the heart of the chick?—We are left to this question, Is it probable that a change shall take place in the fluids which shall stimulate the vessels? or shall the heat of incubation stimulate the vessels to act upon the contained fluids? or, as seems most probable, does the incubation, at the same time, produce a change in the fluids, and stimulate the vessels to action? To explain what I should rather conceive to take place, I shall describe the probable series of actions.

In common feed, the small germ of the plant has its vessels passing out into the lobes of the albumen to absorb the food, upon the existence of the peculiar circumstances

circumstances necessary to its being stimulated to activity and growth. We have to observe, that where the nut was attached in its husk to the tree, it has left a porous part; by this cribriform kind of plate the moisture of the earth enters;—that dry scurfy substance which we observe on the inside of the shell, swells with the moisture which also penetrates the albumen or kernel—the moisture forming combination with the albumen prepares it for absorption; the vessels are, at the same time excited, absorb, and thus nutritious fluids are conveyed to the germ—the nut splits by the swelling of the parts, and the corculum or bud sprouts up.—We find then, that in this instance the grain, or nut, is brought into action by the fluids absorbed, forming new combinations with the albumen or kernel, and the active exertion of the living powers, beginning by an operation in the fluids.

In the same manner, I conceive, that the incubation of the egg causes an action first in the fluids, not in the solids (for these are solids according to the strictest signification of the term; and strong membranes, as a little vinegar will show, when poured upon the albuminous substance of the egg). A change takes place in the fluids, there are new arrangements suiting them for absorption, by those circles of vessels which are laid on the original formation of the membrane. The fluids act as a stimulus to those vessels, whose alternate action and relaxation never cease until the termination of life. I conceive this explanation, which I have offered, to be more consonant with the great principles of physiology, and an extensive analogy of similar actions in the œconomy, than that ex-

planation of Mr. Hunter, which supposes the specks seen at the sides of the vessels, to be spots of coagulated blood, destined afterwards to become blood vessels. For, I am apt to conceive, the red blood to be formed only after several rounds of the circulation, and to depend upon a more perfect assimilation than that first excited : and that Mr. Hunter is all along in this mistake, that he is supposing these vessels to be newly formed, which are laid in the constitution of the membranes surrounding the embryo, and which are now only called into action, and only become apparent when they convey red blood.

In the system of the egg there are other circumstances worthy of notice : as the chick grows by the absorption of the white, or albumen, the new combinations reduce to a lesser bulk the whole mass, which is within the shell, and now we perceive the use of the air-cell, which enlarging, fills up this space. When the chick has escaped from the shell, the yolk of the egg is not exhausted, but it is found to be received into the belly of the chicken, and to have a conduit leading into the duodenum, by which it is poured into the intestinal canal. It is for some time a source of supply to the young animal until its strength is equal to the digestion of its appropriate food. And in this respect it is analogous to the suckling of viviparous animals.

Let us now observe what analogy exists betwixt the generation, or rather the birth and nourishment of the embryo of the viviparous animal, and those of the oviparous. As to the precise effect which the approach of the male has upon the ovarium of the female, whether

whether by this union of the sexes, there is an actual addition to the ovum, or only an influence exerted on the parts already there, by the presence of the male semen, it seems almost needless to hope for an absolute decision.

The resemblance of the offspring to both parents, would influence us at once to conclude, that there must be a union of the parts from both sexes. But when we consider how much the peculiarities of individual animals depend upon certain peculiarities of action; how the constitutional predispositions must depend on the same peculiarities in the action of parts, since the doctrine of absorption teaches us, that of actual substance nothing is permanent, but all suffers an incessant revolution and change, of which nothing can remain but certain peculiarities of action; we may then come to allow, that the male semen merely influences the state of the parts already formed, and does not bestow an actual substance.

In the speculations on the subject of generation, facts and observations have been so very rarely attended to, that those which have been offered seem to have had a preponderance much beyond their real value. Thus the microscopical demonstration of animalculæ swimming in the semen of the male, has given birth to an idea that they were homunculi, which being introduced into the proper nidus of the female, grew up to man's estate. Though, where all is conjecture, and, perhaps, as no better explanation is to be offered, it may seem improper so directly to contradict any theory, still I must say, that this is, in my mind, the height of absurdity. To suppose an animal secreted alongst

with the feminal fluid from the testicle of the male (and which, in all probability, is the production of stagnation and putridity), to swim and be nourished in the male semen, and yet to hold that on being introduced into the ovaria, it changes from an active animal into an impalpable gelatinous-like mass, and, after a series of changes, grows at last to the maturity of a human being, is altogether beyond my comprehension.

The experiments made by the ingenious Dr. Highton, throw considerable light upon these delusive speculations regarding the impregnation of the female. He found by experiments on rabbits, that upon cutting the Fallopean tubes, forty-eight hours after the coitus, the impregnation was equally obstructed as when he had cut them previous to admitting the male; it would appear that in these animals impregnation is by no means the instantaneous effect of the union of the male and female, but that it requires at least fifty hours; for, when Dr. Highton cut the Fallopean tubes at that period, it did not prevent impregnation. Dr. Highton proves, that the generative process is not an instantaneous effect, as we should very naturally suppose, but an operation requiring time. That the semen does not reach the ovaria during, or immediately after the coitus, is sufficiently evident; and it is still more so, that the ovum is impregnated while in the ovarium, and not upon its descent into the womb, which is proved from the fœtus sometimes remaining in the ovarium, or tubes, and growing to maturity. Dr. Highton supposes the semen only to affect the vagina and uterus, and that a consent of parts, or sympathy,

is

is communicated along the tubes and ovary to the ovum; and that neither the semen, nor the aura feminalis reaches the ovaria. When we look abroad for analogies, however, and find the semen of some animals, as fishes, merely thrown out upon the already evacuated spawn, we cannot readily acquiesce in this opinion of the mere sympathy of the female parts calling the young animal into life.

Leaving this subject, we have to observe, that previous to impregnation there is a ripeness and prominence of some of the ova, that by coition the Fallopean tubes do not instantly grasp, impregnate, and cause the bursting of the ovum from the ovarium; but there is an action commenced which gradually brings about this change. Whilst the ovary is thus affected, the tubes are preparing for their action of embracing the ovum, there is an increased turgescence in their vessels, and an enlargement and swelling of the fimbriated extremity. When thus prepared, it approaches the ovarium, grasps, and receives the ovum, and by a peristaltic motion, probably very slow and gradual, the ovum is conveyed into the cavity of the uterus.

OF THE OVUM, AND ITS CONNECTIONS WITH THE UTERUS IN THE EARLY MONTHS OF PREGNANCY.

THE ovum, when it has descended into the uterus, and is perfect in its structure, is a soft oval mass, fringed with vessels, and composed of membranes containing the early foetus. When opened, or dissected, it presents three cavities, or we observe the foetus to be surrounded with three distinct membranes. The

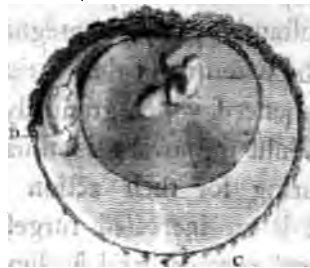


1. Decidua, or tunica filamentosa, false chorion, or spongy chorion. 2. The chorion. 3. The amnios. Of these coats, the outer one is formed by the womb, the others constitute the ovum as it has descended from the ovarium. We shall, in the first place, attend to the original membranes and general constitution of the ovum, and then to the deciduous covering which it receives in the womb.

*Plan of the Membranes.*

p. 263

*Plan of the Membranes.*



A, The Fœtus. B, The Amnios. C, The Chorion, D, The Vesicula Alba.

**AMNION.** The amnion is the vesicle which immediately involves the fœtus. It is a very thin and pellucid membrane in the early stage of pregnancy, but it acquires considerable thickness and strength in the latter months.

The amnion contains a thin watery fluid in which the fœtus is suspended. In the abortion of the early months, we find the quantity of this fluid very great in proportion to the whole ovum, and this forms a defence to the delicate, and almost gelatinous substance of

of the foetus, while it is a provision also for the regular presentation of the head of the child, for now the foetus being suspended in this fluid, and hanging by the umbilicus, and the head and upper part of the body greatly preponderating, it takes that position with the head presenting to the orifice of the womb which is necessary to natural and safe labour, the foetus being prevented from shifting in the latter months by the cloffer embracing of the child by the uterus.

**CHORIAN.** The chorion is the second involving membrane of the foetus; on the inside it is smooth, and betwixt it and the amnion a gelatinous fluid is interposed. In the early months it is much stronger than the amnios, but in the advanced stage it has come in contact with the amnios, no fluid being betwixt them. And in proportion as the amnios gains strength to be of essential service in dilating the orifice of the womb during labour, the chorion has relatively become very thin and weak. On the outside the chorion is shaggy and vascular, and constitutes those minute extremities of the vascular system of the ovum, which attach to the surface of the womb, or rather to the flocculent membrane which it throws out.

**THE UMBILICAL CORD.** When we can first discern the foetus, it is merely like an opaque oval body of the size of a common fly, and closely attached to the amnion; but, by degrees, it recedes from it, and then we perceive that it is attached by the umbilical cord, which consists of the trunk of the vessels going out from the foetus, and which distributed upon the chorion receive the supplies from the maternal system.

Now



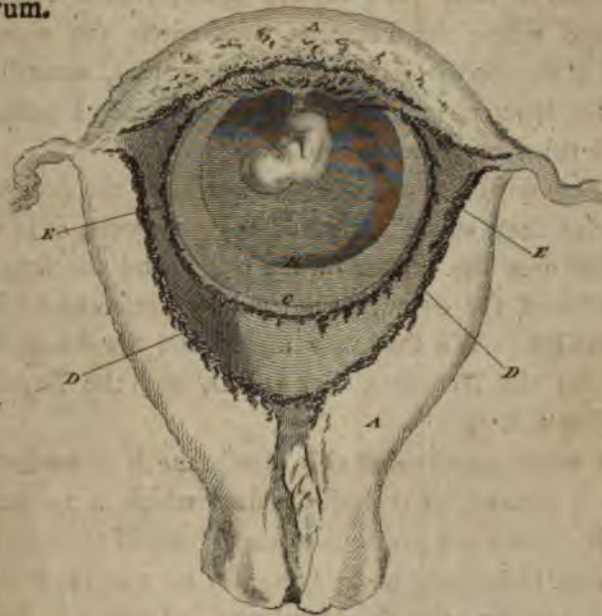
Now we perceive that the foetal system which descends from the ovarium, is not merely a foetus or embryo, but that this embryo, besides a system of vessels within its own body, is surrounded completely with membranes, and that from the vascular system of the embryo, there go out vessels, which being minutely distributed to the outer vesicle, or membrane, and actuated by the same heart which circulates the blood through it, our little corporal system prepares for imbibing the due nourishment from the uterus.

**VESICULA ALBA.** The vesicula alba, or umbilicalis, is a little vesicle which lies betwixt the chorion and amnion; it contains a white fluid; it is connected with the naval or cord, by an artery and vein. Very little has been offered as explanatory of its use, it has been considered as similar to the alantois of quadrupeds, and having a connection with the urachus; but it has no communication with the bladder, and soon disappears. Whereas, if it had been for receiving the secretion of urine, it would have been prepared for the more mature state of the foetus.

I conceive it not to be improbable, that it is a provision of supply for the embryo, previous to its perfect attachment to the uterine system, and during its descent into the womb, perhaps similar to the albumen of oviparous animals, but which, after the perfect establishment of the connection betwixt the foetal and maternal system, shrinks and disappears, as being no longer necessary,

OF THE ADDITIONAL MEMBRANES WHICH THE OVUM  
RECEIVES FROM THE UTERUS.

WHILE the ovum is taking the changes consequent upon impregnation, the womb partaking of the general sympathy which prevails over the whole uterine system, takes a change adopting it for its reception. The first appearance of action is marked by a greater activity of the vessels, a swelling and softness of its substance. While on the inner surface there is an exudation which being converted into a spongy membrane, is peculiarly adapted for the reception and adhesion of the ragged and vascular surface of the ovum.



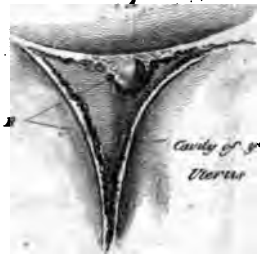
In this plan we shall be able to observe the relations and inflections of the uterine membranes or decidua,

as seen and described by Dr. Hunter, and of their correctness, my observations in dissection leave no doubt in my mind. AA, The uterus in out-line; B, the amnion with the foetus; C, the chorion. Now it is observed, upon a careful examination of an abortion of the early months, that besides the chorion and amnion, there is a spongy membrane of two distinct lamina which invests the chorion. The outermost of these is found to surround the whole ovum, even investing that part which has become the placenta by the accumulation of vessels. This outer membrane then may be represented by the line DD. It is represented as adhering to the surface of the womb, as it must do in fact. We observe again, that it is perforated where the Fallopan tube enters the womb, that at this part it is not formed; so that, according to Dr. Hunter, and the preparations which I possess, these tubes open into its inside.

Upon dissecting up the outer lamina of the decidua, we find that where the placenta commences, it is reflected over the surface of the ovum and the shaggy chorion of the ovum, so as to be represented by the letters EE. We shall now understand the distinction betwixt the DECIDUA VERA DD, and the *Decidua Reflexa* EE.

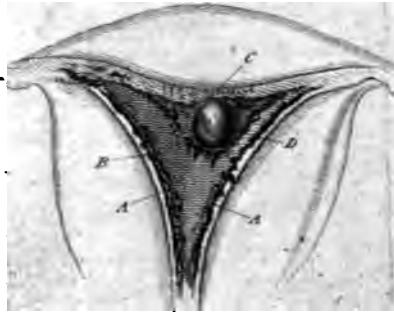
It would appear that this membrane is either completely formed, or at least the fluid which is to form it, is thrown out previous to the descent of the ovum; indeed, so intimate is the sympathy betwixt the whole uterine system, that this membrane is formed in those cases where the ovum does not descend, but constitutes the extra uterine conception.

Dr.



Dr. Hunter supposed, that the ovum passed into the cavity of the uterus whilst the coagulable lymph was pouring out by the arteries of the uterus, and that it was thus immerfed in, and furrounded by the decidua, for he could not conceive that it could gain admiffion betwixt the lamina of the membrane already formed.

I should conceive that the ovum A, upon its defcent gets intangled behind the deciduous membrane B, by which means the ovum is not left loofe in the cavity of the womb, but is foon attached and furrounded with a membrane, or vafcular web, from which it can immediately draw fupplies, and by this provision alfo its adhefion to the fuperior part of the uterus is infured. But as the fame action of the uterus continues, and, as we muft naturally fuppofe, be rather occafioned by the prefence of the ovum in its cavity, the furface of the uterus at A continues to throw out a coagulable matter which furrounds that part of the ovum, fo that this will immediately become its fituation.



**A**, The *Decidua Vera*, formed before the descent of the ovum. **B**, the *Decidua Reflexa*, formed by the ovum getting behind it, and pushing it down. **C**, the efflorescence which continued to be poured out, furrounds the upper part of the ovum, and which, from its more immediate supply from the uterus, will in time form the sole support of the foetus, viz. the uterine portion of the placenta.

#### OF THE PLACENTA, AND OF THE NUTRITION OF THE FŒTUS.

WHEN the ovum first descends into the uterus; the fleecy surface of the chorion establishes a universal adhesion, but no sooner is the attachment of the ovum established, than the vessels of the foetus which are universally distributed over its surface, begin to accumulate to that point from which the more abundant supply is obtained. Thus, from the universal adhesion the vessels of the foetus are massed and accumulated together, so as to form a thick cake or placenta.

centa. This takes place upon the same principle that the roots of a plant stretch towards the soil best suited to it, or the branches and leaves of a plant grow and spread towards the light. The placenta is destined to adhere to the fundus of the womb, and there we observe the accumulation of the large vessels of the womb, it being equidistant from the several sources of blood; and to this point is the tendency of the vessels of the chorion so great, that we sometimes see the vessels of the cord running three or four inches upon the membranes before they reach the placenta, evidently shewing that the point to which the umbilical cord had been originally attached, was not opposite to the more vascular part of the womb; but that the vessels had to stretch and elongate some way from the insertion before they accumulate in form of the placenta, towards that part of the uterus where there was the greater vascularity.

But the formation of the placenta on the fundus of the womb is not constant, although there are many provisions for ensuring attachment there. But when it does form low in the womb, or on the orifice itself, we then perceive the reason of nature's solicitous care in preventing it; for it occasions the most dangerous floodings from the placenta presenting on the approach of labour, and its connections being necessarily torn up previous to the delivery of the child.

The placenta of the advanced stage of gestation is a mass formed partly by the accumulations of the vessels of the foetus (the trunk of which is the umbilical cord), and partly of a vascular and cellular portion  
formed

formed by the uterus. On the surface attached to the womb, the placenta exhibits deep and irregular fissures which divide it into lobes; but on the inner surface is smooth from the investing membranes, but raised into irregularities by the numerous and tortuous ramifications of the umbilical vessels. When rudely torn or cut into, it appears to be a spongy substance, formed in a great part of an irregular tissue of vessels.

In the human subject we find, that the maternal part of the placenta is thrown off with the other secundines, and does not separate from the foetal part of it. While, in other viviparous animals, the monkey excepted, the filamentous extremities of the foetal vessels separate from the glandular mass formed by the maternal vessels of the uterus.

The placental vessels of the foetus never touch the surface of the womb, but communicate with the maternal system through the vessels of the womb, which pierce the deciduous membrane. Still the question of the precise manner in which the vessels of the foetus communicate with those of the mother remains undetermined. I conceive that in the early stage the deciduous membrane being thrown out by the action of the uterine vessels, those of the chorion stretch into it, and absorb the nourishment. The decidua is a vascular membrane, but it has, at the same time, a peculiar spongy texture. This spongy, or reticulated structure of lamina of the decidua ceases where the placenta is affixed. When we carefully dissect up the decidua to the margin of the placenta, it is found to be more rigid



rigid, white, firm, and thick \*. When we examine the outside of an entire ovum, we observe that at the place covering the placenta, it is corrugated and full of irregular eminences like the convolutions of the brain, and amongst those irregularities many small convoluted arteries may be discerned, with spots of extravasation and the flat mouths of veins. Upon dissecting up this maternal part of the placenta, we find it to form the firmest part of it, and by the difference of colour, as well as by the possibility of tearing it up, or dissecting from the mass of vessels of the chorion, we recognize it as the decidua. This union, however, betwixt the maternal and foetal parts of the placenta is intimate, and it is impossible to determine by dissection with the knife, whether there be inosculations betwixt the maternal and foetal vessels, or whether the nourishment of the foetus is by absorption, nor can we distinguish in the first months the cellular intertexture which may be observed in the placenta of the full time, as described by Mr. Hunter.

In explanation of this part of our subject, I have purposely dissected, and made drawings of the ovum in several stages. This point of anatomy relating to the decidua, is particularly explained in Plates VI. and VII. to which I refer the reader.

#### OF THE LIQUOR AMNII, AS CONDUCTING TO THE NOURISHMENT OF THE FŒTUS.

SOME phisiologists observing the strict analogy, which exists between the function of the placenta and

\* I speak after dissecting the ovum of the third month.



the lungs of breathing animals have conceived, that the liquor amnii is the source of nourishment, and that it is taken into the stomach. I believe they have conceived some analogy to exist betwixt the albumen of the egg and the liquor amnii, which in their minds has strengthened this opinion. But there is here no analogy; we have seen, that the embryo of oviparous animals being formed with the yolk in the egg-bed or ovarium, descends into the uterus, and there receives the addition of the albumen or white. On the other hand, we find that the ovum of viviparous animals is formed in the ovarium; and that the liquor amnii being within the membranes of the ovum, must be the production of the foetal system. Further, when the ovum has descended into the womb, and grown to some maturity, we see that there is no connection by vessels betwixt the foetus and mother but through the placenta; that the liquor amnii is within the involving membranes of the foetus, and that consequently it must be thrown out by the vessels of the foetal system. Thus, to suppose the foetus to be fed by the liquor amnii, would be to suppose it to draw resources from its own system, and that the vessels poured out a fluid, which is afterwards to be taken into the stomach\*. But without adducing arguments, it is sufficient to say, that foetuses have been brought forth, monstrous in their conformation, and without mouths yet well grown.

\* A greater absurdity than that of which a foreign author is guilty cannot be imagined, because the liquor amnii, or some fluid, is found in the trachia, he supposes that the foetus respire, and receives origination from the liquor amnii.

OF THE PLACENTA AS THE SOURCE OF NOURISHMENT TO THE FÆTUS. When we consider the mere speck of the embryo in the first weeks, we see that it can have no other source of nourishment than through the extreme vessels of the chorion, connected with the short umbilical cord; and we may be convinced also, that in its progress to maturity, when the general connections of the chorion cease, and the placenta is formed, the sole supply is through its vessels. Regarding the manner of the communication betwixt the vessels of the mother and child there are many opinions. The simplest explanation, but the furthest from the truth is, that the arteries of the womb are continued into the veins of the foetal portion of the placenta. That on the other hand, the arteries of the foetal system are continued into, or inosculate with the veins of the womb; and that thus, the blood of the mother's system is carried by direct inosculatation. A little investigation will convince us, that this is a very unlikely conjecture. We see the embryo surrounded with its vessels, and forming a complete system within itself, descend into the womb. We see that the attachment betwixt the surface of the ovum and the womb, depends on a reciprocal action betwixt them; and when the foetus is feeble, or diseased, or when it dies, the uterus immediately separates from it, as from a dead part, and there is an abortion. Again, it is not natural to suppose, that the circulating fluids of the adult are calculated for the circulation in the embryo, or that the blood of the adult is fit for the circulation of the foetus. When we inject the vessels of the foetus, we find the veins and arteries of the umbilical cord to in-

osculate freely with each other, and the fluid passes from the arteries to the veins with little extravasation or escape of fluid, and such only as may be supposed to pass from torn vessels. Again, the bleeding of the child does not draw from the maternal system; for example, when the accoucheur has to perform the operation of embrioulcia, and when the arteries of the brain pour out their blood, the woman does not suffer, nor is there any danger of hæmorrhagy from the cord after the delivery of the child. Again, what does the analogy of other animals show us? We may observe, in the first place, that probably on account of the peculiar form of the womb of woman, and in these circumstances to guard her from danger of hæmorrhagy during delivery, it is necessary that the placenta should be accumulated towards the fundus of the womb. Now, to allow less danger of the separation of the secundines from the womb, and consequent abortion, there follows a necessity for the human placenta being attached in a particular manner; and in place of the maternal part of the placenta remaining with the womb, as in other animals, the whole mass separates on the delivery of the child. The necessity for this firmer attachment of the human placenta, causes the connection betwixt the foetal and the maternal portions to be very intimate, and the manner of the vascular connection by no means easily demonstrated.

In other animals, however, for example in those which have the small and numerous placenta, or colylidones, the foetal and maternal portions of the placenta separate easily; the maternal part being a prominent vascular bed, which is a part of the womb,  
and

and is not deciduous. Here we find, that the glandular-like portion which belongs to the womb may be minutely injected, and no particle of colour pass into the foetal part; and again injection shows the foetal portion to be merely composed of the fleecy extremities of vessels, which, however, minutely injected, do not show any inosculations with the maternal vessels; in short, here the connection betwixt the extremities of the two systems is so very loose, and the filaments so minute, and almost like an impalpable mucus, that we can imagine no other kind of connection than that the extremities of the umbilical vessels take up by absorption the nutritious matter necessary for the system of the child, and that this is secreted by the vessels of the womb.

Investigation in every department of natural history shows a similarity, and a simplicity in the operations of nature. Comparative anatomy may be brought with much advantage in illustration of the very obscure laws which guide the functions of the parts of generation. When we turn our attention to the egg, we find, in the first place, that the vascular system is complete within itself, and requires no permanent connection with the maternal system to invigorate its action. We find that the artery which passes out of the umbilical cord of the chick, and which is distributed to the membranes of the white, pulsates strongly, and carries venous coloured blood. We find the returning vein carrying arterial coloured blood. We find then that these vessels must have a double function, they imbibe the nourishment from the white, and convey it to the increase of the chick; and they at the same time,

perform an action similar to that of the pulmonary vessels of the adult, seeing that they carry out dark-coloured blood, and convey it back to the chick, of a bright vermilion colour. Now, I do not conceive, that this change upon the blood is performed by the communication with the atmosphere through the shell, for I see no distinction in the colour of the vessels, which are contiguous to the membrane of the shell, and those which are removed from it by the expanding of the air-cell. Further we find, that there is an intermediate kind of generation in fishes which are oviparous, but retain the egg within their womb, until the foetus is matured; here no communication with the air or water can be allowed.

Since we see that the chick in ovo is capable of ministering in every essential particular to its own increase, wherefore should we suppose that the foetus of viviparous animals has any other more particular connection with the womb of the mother?—The difference is in my mind this simply; the ovum of the oviparous animals descending through the convoluted and intestinal-like womb of the hen, accumulates a quantity of matter around it, which serves every purpose of nutrition when the embryo shall be finally separated from the maternal system; but in the viviparous animals the ovum descending into the womb remains there, and has an incessant supply of nutritious fluid, secreted from the vessels of the womb, as it is required by the appetency of the foetal system. As in the egg, the membranes surrounding the white have the same effect upon the blood, which is afterwards produced by the lungs; so has the placenta of viviparous animals the  
double

double function of supplying nourishment, and the origination of their blood. The umbilical vein carries back pure arterial blood, and the common opinion is, that the blood of the fœtus coming in contact with the blood of the maternal system, receives the principle from it, which bestows this quantity of colour, with other necessary qualities, of which this of colour is but the sign to our observation. It is not necessary to this change on the fœtal blood, that it should come in immediate contact with the maternal blood, for it is possible, nay probable, that the matter thrown out by the maternal vessels, whilst it is nutritious, has also in it, in a condensed, and not a gaseous form, that which is essential to the change of the blood of the fœtus from the Modena colour to bright vermilion.

#### OF THE EXTRA UTERINE CONCEPTION.

WE find some curious facts relating to the action and sympathy amongst the parts of generation, proved by the cases of extra uterine conception. When nature, balked and interrupted in her usual course of operation, shows unusual resources, it would appear, that the ovum, after impregnation, has in some cases remained attached to its original seat in the ovarium, perhaps owing to some want of due sympathy and synchronous action of the Fallopean tubes, which should grasp and receive the ovum. In other instances the ovum has been received into the Fallopean tubes, but either from a want of sufficient dilatation and action in them, they have not been able to propel it forward,

ward, or the ovum taking upon it that action which is destined to form its connections with the uterus, adheres, and is enlarged in the tube, so that it cannot be conveyed down into the womb.

But the most curious instance of the extra uterine conception is, where after impregnation the ovum has dropt from the ovarium, and lies in the cavity of the abdomen amongst the viscera. Here also the vessels of the fleshy chorion spread, and attach themselves to the surface of the viscera.

These instances of deviation from the natural action of the parts after conception prove to us, I think, that from the moment of impregnation there is a principle of life and activity in the system of vessels of the ovum, and that at a stated period this action becomes such, that the efflorescent vessels of the surface of the ovum, attach themselves to whatever vascular surface they are in contact with. Further, it seems to shew, that in the womb, and in the deciduous membrane which it prepares for the reception of the ovum, there is nothing very particularly necessary, and that any vascular surface will take upon it the same changes, and being excited probably to some peculiarity of action, will in every thing essential supply the growth and nourishment of the ovum and foetus.

It shows us how far the action previous and consequent to impregnation is a universal and sympathetic excitement of the uterine system; that the decidua is formed in the cavity of the womb, although the ovum does not descend. This points out to us how careful nature is, that there shall be a reciprocal action in the ovum and womb, so as to ensure the adhesion of the  
ovum,



ovum, and the ready supply of a proper nidus for it, when it shall have descended into the cavity of the womb. It informs us, that the uterus is a spongy and vascular bed, having peculiar sympathies which actuate its vessels, and a form of vessels adapted to quick acceleration of action so as to grow, enlarge, and supply the secundines with nourishment.

It is not, however, in the mere adhesion and supply afforded to the foetus, that the peculiar adaptation of the womb for the reception of the foetus is shown, but in the provision for the delivery of the child at a regular and stated period. For, it is a curious fact, that in the case of extra-uterine foetus, on the expiration of the nine months, the uterus takes upon it that action, and that excitement of its muscularity which is destined to expel the foetus. Accordingly we find, that at the usual time of utero-gestation, there are pains excited, and flooding, with the discharge of the decidua from the womb, although it contains no foetus.

Nay, further it would appear from the result of several cases, that at the expiration of the natural term of utero-gestation, the foetus indicates that it is governed by prescribed laws, which render a change necessary, and show that its system is no longer fit to be supplied through the placental vessels, and as in the situation of extra-uterine foetus this change cannot take place, it dies and becomes with its secundines, as a load of foreign or dead matter in the belly. This event is generally followed by the death of the mother, though sometimes an abscess has opened and discharged the foetus, or after much suffering, the bones  
have



have been discharged by stool, with much matter and colliquative diarrhæa.

OF THE WOMB AT THE FULL PERIOD OF GESTATION  
AND OF DELIVERY.

To complete this view of the female parts of generation, it remains only to speak of the state of the parts at the full term of nine months, and to observe the process of a natural delivery.

The rapid increase of size of the pregnant womb in the short space of nine months, is perhaps the most surprising phenomenon of the whole animal œconomy, it shows the power of a peculiar excitement in calling into action a partial and local system of vessels. This state of pregnancy is the farthest from a state of distention, in so much, that it is observed the womb feels peculiarly soft on impregnation, and as if but imperfectly filled by the ovum. This soft state is a sign of vascular action. We may often observe in the dissection of a tumor, that before any change takes place, it swells and becomes soft, and this even where the tumor is about to be absorbed.

The fundus of the uterus is the part first enlarged; and afterwards the inferior parts; at length the cervix is obliterated, and the uterus, which was originally pyriform, becomes nearly oval, and the distention, as we have remarked, is greatest on the back part of the womb. In the first months the uterus sinks lower in the pelvis, they say, from its weight, but the specific weight of the uterus is not increased, and on that account it should not sink deeper; it is, perhaps, rather  
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from its enlargement, and the difficulty with which the fundus makes it way among the viscera in the brim of the pelvis. Having descended considerably, the os tincæ projects further into the vagina, but the fundus continuing to enlarge, at last emerges from the circle of the bones, and then from the conical form of the uterus, it sometimes rises suddenly out of the pelvis; now the vagina will be found elongated, and the os tincæ removed from the point of the finger.

Now the ligaments of the womb direct it forward, and it rises close upon the abdominal paries, and before the bowels; in the first pregnancy it rises almost directly up; in subsequent pregnancies from the greater relaxation of the integuments and the abdominal muscles, it is allowed to fall more forward; about the fourth month of pregnancy, the womb may be felt in the abdomen, and rising out of the pelvis; in the fifth month the fundus is about half-way betwixt the pubes and navel; in the seventh, it is about half-way betwixt the navel and scrobiculus cordis; in the eighth, it is at its highest, and towards the end of the ninth month, it rather subsides. Finally, immediately before labour it descends remarkably, and shifts into the middle of the pelvis, so as fairly to present the orifice of the womb.

The muscularity of the uterus is increasing from the first moment of pregnancy. As the uterus increases in thickness and is distended, the muscular fibres become more distinct, and their power of contraction greater; but what is very particular is the great muscular efforts made by the womb during labour by these fibres, which have not till that time felt the stimulus to action, or been allowed to contract.

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When the period for the approach of labour is arrived, the nature of that viscid secretion which seals up the orifice of the womb is altered, it loses its viscosity, and all the parts are relaxed and prepared for the transmission of the head; even those rigidities, strictures, or callosities of whatever kind, which would seem to promise an absolute obstruction to the passage of the child, yield and relax previous to labour. The action of the womb is at first feeble, as might be expected, and accoucheurs have marked these stages of a natural labour.

1st. The womb has suffered no diminution of its size; the membranes are entire, and, of course, the contractions of the womb are feeble, because before it is allowed to make some contraction its efforts are not strong. This is a provision for the first stage of labour being slow; by and by the orifice dilating, the membranes with the waters are felt protruding. The membranes and water is as a soft conical cushion, gently dilating the passage; and in this stage there should be no officious interference. While the membranes are entire, both the mother and child are in perfect safety.

2d. The orifice continuing to dilate, and the efforts of the womb increasing, the membranes burst, and the head of the child presses on the orifice; then the womb is allowed to contract: this contraction is a stimulus to greater efforts, and, in a few pains, the head descends in to the cavity of the pelvis. The orifice is completely retracted, and there is no longer a mark of division betwixt the womb and the vagina; they are as one canal. If, however, the membranes  
are

are burst too early, the labour is not accelerated, but retarded. The orifice is not dilated by the soft and elastic membranes; the head of the child presses broad on the orifice, which becomes rigid, and perhaps inflamed, its dilatation is slow, and the labour tedious. Though, from the form of the bones, and particularly by the retiring of the sacrum, there is a provision and guard for the soft parts of the mother against compression by the head; yet nature intends this stage to be short, for it is the period of danger. There is now obstruction of urine and fæces, and the vessels of the parts suffer compression.

3d. Now the head of the child presenting at the orifice of the vagina, forms a third stage; it is the stage of most exquisite suffering: the head is pushed forward during every pain, and recedes again in the absence of pain. An interval of rest precedes this stage, at last the pains return, and the hard head of the child coming to press on the orifice, and the womb coming in close contact with the body of the child, the pains are redoubled in strength. The face of the woman, perhaps, before pale and flat, becomes red and turgid, the eyes gleam, and are inflamed; the pulse becomes quick and hard; and from the exquisite expectation of relief, she looks wildly round on her attendants, losing all reason and recollection; she is frantic, with the most agonizing pain to which the human frame is subject. Now the occiput of the child begins to project with its wrinkled scalp through the external parts, but nature intends that this also should dilate slowly; the ligaments and os coxigis resist several throes, and direct the  
head

head forward under the pubes ; at last, after several pains, it rises with a half turn, and is delivered.

4th. The fourth stage, is the delivery of the body and shoulders ; and,

5th. The fifth stage, is the delivery of the placenta. The placenta is expelled by a continuation of the same action of the womb, and is part of the natural process. First a flow of the liquor amnii and blood follows the child, and the woman lies for a time exhausted ; the extreme pain and excitement having ceased. The womb generally recovers its powers in about twenty minutes, and then there is grinding pain in the belly, and the placenta is detached and expelled, or is pushed down into the vagina.

Thus we have sketched, in the most superficial manner, the progress of a natural labour, with a view merely to explain the general notion of the entire function of the womb, not with that minuteness which the accoucheur would look for in treating the subject. Let us, for an instant, attend to the state of the umbilical cord, and the final contraction of the womb.

I have already observed, that while the membranes are unbroken, the child is safe, that is to say, there is no danger of the compression of the umbilical cord ; but when the membranes have burst, and the waters are evacuated, the cord must suffer a degree of compression betwixt the uterus and the child, and there is danger that the cord may fall down before the head, until the head has descended into the brim ; as the uterus contracts, and as it were follows the child, the circulation through the placenta must become some-

what difficult, and the usual function corresponding with that of the adult lungs impaired. This must be much more the case when the child is delivered, and the placenta remains in the contracted womb. No doubt nature intends by this, that the function of the placenta shall be gradually diminished, and not suddenly cut off, that the child may feel occasion for the play of the muscles of respiration, and that the function of the lungs may, by degrees, take place of the function of the placenta. When the child is first delivered, the cord pulsates strongly; when the child cries, it becomes feeble; at first, the child has strong and irregular catches of the respiratory muscles, but by and bye it breathes more regularly, and cries lustily. At first the breathing only renders the pulsation of the cord feeble, but presently the pulsation becomes so weak, that it is felt only near the umbilicus, and it ceases when the regular and interrupted breathing is established, and the crying ceases.

The delivery of the child and placenta is followed by a considerable efflux of blood. But after this there continues a discharge from the uterus, which is called the lochia. It is like the exudation of blood from an extensive wound, in as much as by the contraction of the vessels from which it flows, it becomes serous in a few days, and ceases gradually like a hæmorrhagy.

This open discharge from the womb after delivery, is no doubt a provision against the consequence which would naturally result from the sudden and perfect obstruction, and the activity of the uterine vessels consequent on delivery. By this discharge the activity of  
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the vessels is gradually relieved, and as it is a discharge taking place of the active state of the womb, so the secretion of the milk in the breasts, and the giving of suck, causes the discharge to cease much sooner than it would do if the mother were not the nurse.

## OF THE MAMMÆ.

IN man and in children of both sexes, there is no mark of the breast, but the little cutaneous papilla, or nipple. These tubercles are, however, surrounded by a zone or disk, of a brownish red colour, the areola.

At puberty, as we have said, the breast of the female becomes protuberant, and those parts which were in miniature, and without action, quickly grow into a firm glandular mass (speaking anatomically). The shape, rotundity and firmness of the gland depends much upon the adipose membrane surrounding and intersecting the glandular body.

The glandular part itself is divided into little masses, which again consist of small granules. These several subdivisions of the glands are closely surrounded by membranes.

The lactiferous ducts are gathered together from these lesser granules, and unite into 12 or 15 in number of a very considerable size, as they converge towards the root of the nipple. When milk is secreted, the glands are large, a remarkable distention of the ducts also takes place, for they are then become tortuous and varicose, and serve as reservoirs of the milk. Where they pass through the nipple, however,

they are again contracted, and open by small pores upon its surface. The nipple is of a spongy and elastic nature, and suffers a distension or erection. When the nipple is contracted, the lactiferous ducts must be compressed, and perhaps coiled together, so that the milk cannot flow, or flows with difficulty: but by the sucking of the child, the nipple is distended, and the ducts elongated, so that the milk flows. There open upon the areola several superficial or cutaneous glands, which pour out a discharge to defend it and the nipple from excoriation.

Of the arteries, veins, or lymphatics of the mammæ, we need not treat here.

We have many occasions to observe the consent and sympathy which exist betwixt the womb and the breasts. On the first period of the menses, the breasts are much distended. In many women at each return of the discharge, a degree of swelling and shooting pain is felt in them, and the enlargement and shooting pain in the breast, with the darker colour of the areola, is marked as the most prominent sign of pregnancy: with the ceasing of menstruation, which is the cessation of the usual excitement and action of the womb, the breasts contract and are absorbed. Any unusual stimulus or irritation in the womb, as polypus, or cancers, or even prolapsus and excoriation, will affect the breasts, causing them to enlarge and become painful.

When the function of the parts cease, they seem to feel the want of the usual excitement to correct action, and are apt to fall into disease; so it is at least with the womb and mammæ, for at that period of life, when



the system is no longer able to support and give nourishment to a child, and these parts subside from their usual action, they often become schirrous or cancerous, and terminate existence by a tedious, painful, and loathsome disease.

**PART THE FOURTH.**

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***OF THE LYMPHATIC AND LACTEAL  
SYSTEMS OF VESSELS.***



C H A P. I.  
OF THE LYMPHATIC AND LACTEAL SYSTEMS  
OF VESSELS.

## INTRODUCTORY VIEWS.

**W**E have understood that the red blood circulates in the body, through vessels (the arteries and veins) which have a direct communication at their extremities by anastomosis; that although these vessels lie parallel to each other, and extend from the heart to the remotest part of the body, yet the blood is said to pass through the circulation, because it is transmitted from the veins into the arteries through the medium of the heart; and from the extremities of the arteries directly into the veins, returning again to the centre. In this transmission of the blood through continuous tubes, there is, in the coats of the vessels an alternation of contraction and relaxation which impels it forward. But besides these arteries and veins carrying the red blood through the body, there are other vessels more remote in their connection with what is generally called the circulating system of vessels.

## SECTION I.

### OF THE CAPILLARY VESSELS.

THE capillary vessels are those extreme branches which are as minute as hairs; but this, though the  
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literal, is not the general meaning of the term. By capillary vessels is rather understood those branches in which the changes are wrought from the blood, and which are either so minute as not to allow the promiscuous flow of the blood, or possessed of such a degree of irritability and appetency, as only to allow certain parts of that fluid to be transmitted.

It is proved that in the living body there is no exudation; but no sooner is the animal dead, than the fluids exude from the vessels, the secretions pass through the coats of those receptacles which formerly contained them, and the whole parts partake of an universal colour. From this simple fact, we are led to think that a property exists in the living fibre, which by contraction or some other property repels the fluids. Admitting this, it is very natural to suppose that the fibres, and more particularly the vessels, have a discriminating property; so that the capillary texture of each organ possesses sensibility, which has its relations to the fluids passing through them, or to be secreted from them.

If we admit this, we may also foresee the explanation of the most puzzling phenomenon of inflammation. Inflammation is the effect of excitement: there is increased action of the arteries; and by the operation of the same cause, there is a destruction of the natural sensibilities of the capillary vessels, so that they no longer are possessed of their distinguishing sensibility, and they admit the promiscuous passage of the red blood: they become dilated by the action of the arteries, and visibly distended with red blood. The effect is not merely the mechanical derangement of the  
particles

particles of the blood. The chemical changes which take place in the extreme vessels are disordered, and the blood deposits upon the extreme branches of the nervous system an unusual proportion of irritability; so that with the redness arising from the circulation of red blood through the hitherto pellucid vessels, in parts not endowed with sensibility, there is acquired an unusual sensibility, and the power of transmitting the sensation to the sensorium. Since we see that in an inflammatory state the pellucid veins transmit red blood, and that this red blood must be supplied by the serous arteries; then it is proved that answering to the pellucid arteries (in their natural state) there are pellucid veins. We should acquiesce therefore in the opinion that supposes both the arteries and veins to have pellucid capillary branches answering to each other, collateral to the larger and more palpable anastomosis of their red extremities. These anastomosing branches of the arteries and veins in which the red blood is seen to circulate, perpetuate the flow of the greater part of the blood back to the heart, while the several secretions are performed in the capillary vessels\*; but there is no reason to suppose that the fluids sent from the arteries into these pellucid capillary vessels are all poured out in form of secretions: part returns into the extremities of the circulating veins. The secreted fluids and solids are either carried away by ducts into their receptacles, or thrown out from the body: while those fluids which are exuded on the cellular membrane and cavities are re-absorbed by the system of absorbent lymphatics.

We say then that arteries terminate, first, in red veins; which is proved by the microscope, and by mercurial

and other injections ; secondly, in glands ; thirdly, in cells receiving red blood ; fourthly, in lymphatic veins ; fifthly, in exhalents, which pour their fluids into the cellular membrane, cavities, joints, &c. and which fluid is taken up by the valvular lymphatic absorbents.

But these absorbent vessels, of which we are now to treat under the division of lymphatics, do also perform a circulation, in as much as they convey back to the centre of the system the fluids, which have been thrown out from the extremities of the arteries. But as these lymphatic vessels are not continued from the extremities of the arteries as the red veins are, as they imbibe the fluids, which have been thrown out of the other system ; their fluid contents cannot be conveyed through them by the force of the heart and arteries, they must be peculiar in having powers within themselves, first of absorbing, and then of propelling their fluid onward to the heart.

This common property of absorption in the lymphatics, absorbents, and lacteals, and their being connected with the same trunk, occasions their being considered as one system of vessels ; when, in fact, looking upon the general œconomy of the living body, we find them ministering to very different purposes. The one branch of the system, the lymphatics (as we have seen in the introduction to this volume), takes up the matter which has been secreted, and poured out from the arteries, (viz. all the solids and fluids of the body,) and conveys it again into the circulating system. The lacteal vessels on the contrary, are those vessels which opening upon the inner surface of the intestines receive into them the nutritious fluids, prepared by the organs

organs of digestion, and suited to supply the incessant waste and destruction of the solid and fluid parts of our frame, and which have been absorbed and carried away by the lymphatics. Following this simple view, although the absorbent system be commonly divided into the thoracic duct, lymphatics, lacteals, and glandular apparatus attached to them, I shall throw the present section into the divisions of the lymphatics and of the lacteals.

## SECTION II.

## OF THE LYMPHATIC SYSTEM IN PARTICULAR.

THE lymphatic vessels are tubes whose coats are perfectly pellucid, having a remarkable power of contraction, which causes them to shrink, and disappear, so as to render it difficult to demonstrate them. Indeed they are only to be observed by an eye accustomed to the making of lymphatic injections. They are called LYMPHATICS, or DUCTUS AQUOSI, from their transmitting a fluid colourless as water. When they are distended with their fluids, they show that they possess a very distinct character from the other circulating tubes. They are irregularly distended, knotty, and sometimes like a chain of beads, or little irregular vesicles connected together. This irregularity is owing to their numerous valves, which are semilunar membranes, like those of the veins, and hung across their cavities, so as to catch and interrupt the reflux lymph. They say, in general, that in the space of an inch the



lymphatic vessel has three or four pairs of valves. But this bears no certain proportion ; for as these vessels run where they are exposed to occasional compression from the surrounding parts, or bear the weight of a high column of fluid, their valves are more frequent. The lymphatics are improperly called cylindrical tubes, since they are irregular from their valves branching and frequent communications. The coats of the lymphatic vessels are the strongest of any in the body ; for although extremely thin and pellucid, they give resistance to distention beyond a certain point, and bear a column of mercury which would burst through the valves of veins, and tear the coats of arteries. If there be a muscular coat, and no one ever denied the muscularity of the lymphatics, then we may reckon three coats : First, The inner coat, which is the continuation of the inner tunic of the veins, as may be observed in the opening of the thoracic duct into the left subclavian and left jugular veins. It is smooth and polished, forms duplicatures or valves, and prevents the transudation of their fluids : it is connected by cellular membrane to the middle coat. Secondly, The muscular or middle coat, which consists chiefly of muscular fibres, which, according to Sheldon, run in every possible direction, though the greater number take the circular direction. And, lastly, the outer coat, which is connected with the general investing cellular membrane. As the inner coat must chiefly form the valves, and as the valves possess so wonderful a power of resisting the column of mercury, I should hold that the inner coat is that on which the strength and resistance

ance to distention of the lymphatics depends, though it has been said that it is to the outer coat that they owe this property. The muscularity of these vessels is rather inferred than proved : it is inferred from the unassisted action which they have to perform in pressing the absorbed fluids onward to the heart. Nevertheless we sometimes see the lymphatics of the lower extremities of a colour so red and fleshy, that we may say their muscularity is demonstrable.

The lymphatics seem to possess little elasticity ; when they are blown into, they rise with the slightest force, and remain distended, although the passage of the air forward be uninterrupted : whereas, had they considerable elasticity, they would contract and disappear. Indeed, when empty, in the dead body they may be rather said to be collapsed than contracted.—Although the lymphatics can be distended with the slightest inflations, yet when distended, as we have already observed, they firmly resist further dilatation. This is a quality necessary to their valvular structure, for if they were elastic beyond this degree of dilatation, the caliber of the vessel would be occasionally so enlarged as to render the valves incapable of meeting, and of preventing the retrograde movement of the fluids.

### SECTION III.

#### OF THE GLANDS OF THE ABSORBENT SYSTEM.

EVERY where throughout the body and viscera betwixt the extreme branches of the absorbent system  
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and the trunk, glandular bodies are interposed. Though of various forms they are generally of an oval shape, and they vary in size from the twentieth part of an inch to a full inch in diameter. Sometimes they are segregated,—sometimes accumulated and clustered together. The colour of those bodies is various in the several parts of the body: in young animals they are redder, and become pale only with age. They are redder and stronger in the outer parts of the body, as in the thigh, axilla, &c. less so within the abdomen and thorax. 2. The latter will not bear so high a column of mercury as the former. The mesenteric glands are said totally to disappear in old age\*.

It would appear that the glands of this system are of more importance to young animals than to adults. In the foetus and in children the lacteal and lymphatic glands are exceedingly numerous; but they shrink or disappear with old age. In the foetus, indeed, they can be of no very essential use; they are then rather in a state of preparation for the actions necessary in infancy and youth. It is then also that they are most liable to disease, and seem more irritable and ready to inflame, especially in superficial situations. About the age of fourteen or fifteen this disposition is changed, which is commonly said to proceed from the increased vigour of the constitution, and the change which then takes place on the organs of generation. It is rather to be attributed, however, to the diminution of irritability and activity of their vessels in verging to the adult state, which is marked by their comparatively less size, and smaller de-

\* By Ruyfch, Morgagni, Haller, Sheldon.

gree of vascularity. We may further observe that the lymphatic glands, even in the serophulous diseases, are seldom primarily affected : that they partake of diseased action from the surface, or from an affection of the intestines, or from the absorption of matter. The structure of these glands has not been satisfactorily investigated ; or the inquiry is attended with insurmountable difficulties. Some anatomists have said, that they consisted of the convoluted absorbent vessels ; others that they are of a cellular structure. When they affirm that these cells are totally distinct from the lymphatic vessels, it is not so easy to understand them : for cells communicating with each other, and into which the lymphatic vessels enter, are very much the same with a series of convoluted, varicose, and irregularly dilated vessels. If we could dissect this series of cells, as Haller did the *vesiculæ feminales*, we should have represented to us the appearance of a convoluted varicose vessel.

There is a coat of cellular membrane which surrounds the glands. This coat is pervaded by a peculiar fluid which has given rise to some speculation. It is observed chiefly in young animals, and is for the most part, though not always, white and milky, and in the glands of the lungs it is of a blackish colour. This is the fluid which having globules in it, was supposed by Mr. Hewson to be the first stage of the formation of the red globules of the blood. It is distinct from the absorbed fluids, and is a secretion from the arteries. Physiologists have not determined the nature or use of this fluid.

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At present there seems no better hypothesis to be offered regarding the use of the lymphatic and lacteal glands, than that they serve to check, controul, and measure the flow of the absorbed fluids into the mass of the blood : without them it appears to me probable that at one time the lymph returning from the body, or at another time the chyle, might flow too rapidly, and in a disproportioned quantity into the veins and heart. But by the check which the glands impose upon this flow, giving a remora and serving as receptacles of the absorbed fluids, those fluids are poured with a more uniform and constant flow upon the heart.

#### SECTION IV.

##### ORIGIN OF THE LYMPHATICS, AND OF THE DOCTRINES OF ABSORPTION.

THE lymphatics, forming a system of absorbents, we might say, in general, that they take up all the fluids which have been thrown out upon the surfaces of the body. Thus they arise from the surface of the skin ; from the surface of the cavities and viscera covered by the pleura and peritoneum ; from the cells of the interstitial and adipose membrane, &c. This is the simple use assigned to this system of vessels : but whether they are the only system of absorbents ; whether they carry away all the parts of the system, fluids and solids ; whether they absorb the muscles, membranes, bones, tendons, &c. of which the solid body consists, is a question requiring severe examination. It cannot be denied that although the system and doctrines of absorption

forption be the most beautiful and interesting, and apparently the simplest in the whole œconomy, yet it is founded on very few facts, while there is much doctrine tacitly acknowledged, which seems in symmetry with the facts and the laws of the œconomy, but which is not founded in absolute proof. We shall first examine the proofs of the lymphatics being the vessels which absorb the fluids of the cavities and surfaces of the body. The animal machine universally partakes of motion. A principal provision for this mobility of parts, is the looseness of the cellular membrane which every where pervades the body, and supports the vessels and connects the several parts. This interstitial membrane is elastic, and being cellular, to allow of motion, its surface is bedewed with serous exudation. This fluid is perpetually passing from the extremities or sides of the lymphatic arteries or capillaries, into the cellular membrane, and upon all the cavities of the body. The fluid extravasated is called lymph, and some have supposed that it passes through inorganized pores, an expression that is not very intelligible; but if by this is meant (as has sometimes been explained) "accidental pores" in the sides of the vessels, it is a supposition quite improbable and unlikely \*. The

\* Dr. Hunter supported this opinion (Commentaries p. 40,) viz. "that the fluids of cavities were collected by transfusion, and not thrown out by exhalents;" an opinion which could only have arisen from not correcting the ideas received in making injections in the dead body by the phenomena of the living system. See *Hewson on the Lymphatic System*, chap. viii. where the opinion of inorganical filtering is successfully combated.—See also Cruickshanks.

pores or vessels from which this fluid exudes are called exhalent; and their action is no doubt as completely secretion as that which produces the fluids, which in our wisdom we call more perfect secretions.

That the lymphatics take up the fluids thrown out in the cavities of the body, as the abdomen, thorax, pericardium, &c. there is what nearly amounts to an absolute proof, in comparing the fluids of those cavities with that contained in the vessels, for by the experiments of Hewson it is found that if the fluid moistening the cavities be collected, it will form a jelly when exposed to the air, as the coagulable lymphatic does. Again, if a lymphatic vessel be tied up in a living animal, and then opened so as to allow the fluid to flow into a cup, it will also form a jelly like the coagulable lymph\*. The fluid of cavities alters in animals diseased; sometimes retaining its coagulability, and even acquiring stronger powers; sometimes losing it altogether. But what is most essential to our present purpose, it has been observed, that whatever change

\* But, by disease, the fluids in the cavities and cellular membrane is altered. In dropfy, for example, the fluid of the abdomen loses the property of coagulating on mere exposure; it comes to resemble more the serum of the blood: this were sufficient proof that the collection is not owing merely to the diminished absorption, but that there is a change of action in the vessels of the peritoneum, pleura, pericardium, &c. An inflammatory action of the vessels will throw out a fluid more coagulable, and which, in a high degree of action, will form a film of coagulable lymph or even pus on the surface. But in a state the reverse of inflammation, such for example as the debility following inflammation, a serous effusion will be poured out, having little tendency to coagulate.

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takes place in the fluids of the cavities, the same is found to have taken place in the lymphatics.

But the student naturally asks, how is the lymph taken into the lymphatic vessels; and here it must be confessed, there is too much field for conjecture.

It was thought formerly that the lymphatic arteries terminated in small pellucid veins: these veins carrying only the thinner, and refusing the red part of the blood, were called lymphatics. When the anatomist threw in his minute injection, and saw the coloured fluid return by the red veins, and the colourless fluid return by the lymphatics \*, it was held as a sufficient proof of the accuracy of the preconceived notion, and tallied with observations of Leewenhoeck, and the theory of Boerhaave. See Introduction to Vol. III. When, however, anatomists more carefully examined the state of parts, they found that the lymphatics were not filled, unless the cellular membrane was previously injected by the extravasation of the fluid from the blood vessels. Finding that this alleged experiment was really no proof of the anastomosis, and direct communication betwixt the extreme arteries and lymphatics, they conceived that it was a proof that these lymphatics took their rise from the cellular interstitial texture. Then injecting with mercury, they found that when the vessels burst, and the column suddenly descended, and the cellular membrane was filled; the mercury was seen to rise in the lymphatics. Following up this, they blew air, or injected various

\* It was probably Nuck who first injected the lymphatics from the arteries.



fluids directly into the cellular membrane, and injected the lymphatics. Thus by an error, by an accidental effect of their injection, the minds of Dr. Hunter and Monro were opened to a freer discussion of the received opinions and approved authorities. Soon, however, it was understood by those conversant with anatomy, that these accidental injections of the lymphatics did not prove the lymphatics to take their origin either from the cells or from the extreme arteries; but already this good effect, at least, was produced, that men's minds were excited to inquire after new facts and trains of observation. It was now recollected, that a strict analogy and correspondence subsisted betwixt the lymphatics and lacteals; the proofs of the lacteals being absorbents, were recalled to memory; new proofs of their being the sole absorbents of the intestines were brought forward; the nature of the fluids effused into the various cavities and cells of the body was attended to; and the conviction followed, that the most essential use of the lymphatic vessels was to serve as a system of absorbents, to take up the extravasated fluids. They reflected that to distend the intestines with injection would never fill the lacteals; and were convinced that the injection of the lymphatics could not be supposed to be through the proper absorbing mouths of these vessels opening upon the cells; but rather that the injection had entered the vessels by the rupture of their extreme branches. Thus the *theory* of the lymphatics being a system of absorbents, came to rest on analogy, and the observation of the phenomena of the living body.

The

The chief proof of the lymphatic absorption has been derived from the manner in which the venereal virus is received into the system. Venereal matter being allowed to lodge upon the delicate skin of the glans penis or preputium, causes an ulcer there. The matter of this ulcer is absorbed by the lymphatic of the part; an inflamed line is sometimes to be traced into the groin; and the lymphatic gland of the groin receiving this absorbed matter, inflames and forms the bubo. Here, then, is a proof that the red veins do not absorb, and that lymphatics do: else why are they inflamed,—and why are the lymphatic glands inflamed to suppuration.

We must observe, however, that this is by no means an absolute proof of absorption; nor is there here unequivocal evidence of venereal matter having been absorbed. Although, therefore, we believe in the general system, we may hazard these queries:—If this matter is absorbed, why is there no infection without ulcer (chancre) of the glands? If this ulcer be produced by absorption, how comes it that the constitution is not infected by the first absorption of the matter, and before it has formed an ulcer? Is it not probable that the irritation of the venereal matter, lodging on this vascular surface, and without being absorbed, causes a peculiar inflammation, the tendency of which is to form a pustule, and to produce matter similar to that which originally infected the part with the specific and peculiar action? Again it will be said, however the venereal pustule was originally produced, it appears evident that the absorption of this matter, the conveying of it along the lymphatic, inflames the vessel, and the next

lymphatic gland into which it enters, receiving the venereal matter, inflames and suppurates, &c. But again, I choose to say, with every show of likelihood, that neither is this a proof of absorption; but that the lymphatic vessel being very irritable, and always receiving its stimulus to action from its extremities, it has partaken of the venereal inflammation; that this inflammation has been propagated to the gland; that, the gland being formed of the convoluted lymphatic vessels, the effect of this inflammatory action is then accumulated to so great a degree as to destroy the function of the gland and lead to suppuration\*. And further, that the disease is received into the constitution only in consequence of the system at large partaking of the irritation (a word which but imperfectly expresses the change) of the local action of vessels. Matter might be absorbed and taken into the constitution, and the disease propagated according to the common explanation; but, according to that offered here, there must be a primary and local disease, from which the general affection is propagated. If we are to take the inflammation and hardening of the lymphatics and axillary glands as a symptom of absorption from a diseased mamma, we must acknowledge the same proof in evidence of the veins absorbing: for although the lymphatics are more active, and their activity depends on the state of their origins and extreme branches,

\* If a chancre be indolent, although matter be formed in it, no bubo will be produced: but if the surgeon applies some corrosive dressing, which, instead of entirely destroying the diseased part, inflames it; then will the gland in the groin sympathize and rise into a bubo.

more irritable, more vascular (I will venture to say), and more liable to inflammation than the veins; yet are the veins affected in a way that would as unequivocally prove them to be absorbents, for we see how they enlarge around a diseased breast, become prominent and hard, and lose their softness and elasticity. But, as we would not say that this is a proof of absorption by the veins, neither is the proof unequivocal that there is absorption by the lymphatics. Again, a suppurating stump, with bad inflammation, will cause inflammation of the lymphatics, and suppuration in the glands of the groin\*; a proof of absorption of the matter of the stump: but we do not find that from such a stump the veins ascend, inflamed and suppurating, while sometimes a chain of abscesses is formed for a considerable extent. This, we can have no doubt, is the effect of the inflammation continued along the vessel; and is not the inflammation produced precisely in the same way in the lymphatic?

I found my opinion of the lymphatics being absorbents,—first, on the circumstance that their structure is adapted to this action; secondly, on the analogy between them and the lacteals, in which absorption is proved; thirdly and lastly, upon their continuing to receive and transmit their fluids, after the heart and arteries have ceased to beat, and the red blood to circulate: for then how can they act, but by their own powers? How can they receive fluids, but by absorption? Finally, this phenomenon shows in the lymphatics, a greater degree of irritability, and stronger principle of activity and tenacity of life, than actuates any other set of vessels.

\* See Hunter's Commentaries.

## OF THE ABSORPTION OF SOLIDS.

ON examining the works which within the last forty years have contributed to throw light on this subject, we at once acknowledge how necessary it is for that part of a systematic book of anatomy, which professes to treat of absorption, to take the form of a critical inquiry. When the absorption of the fluids of the cellular substance, or in the cavities, was universally assented to, physiologists did not make sufficient distinction betwixt the absorption of the fluid thrown out of the influence of the circulating vessels, and that matter which continued to be involved in the membranes and vessels, and which formed the solid part of our frame. It will readily be allowed that the fluid thrown out upon the surfaces of the body and in the cells, might be absorbed without inferring that every part of the body, solids and fluids, were also taken up by the lymphatic absorbent vessels. But physiologists observing that the solid parts of the body were suffering perpetual change; that the whole body and the vessels themselves were formed, decomposed, and carried away; they hesitated not to attribute this to the deposition from the arteries, and the absorption by the lymphatics. This alternate destruction and renovation of parts, the perpetual change which the whole body suffers, has been universally acknowledged and attributed in part to the operation of the lymphatic system, without any other proof than a slight analogy.

The interstitial fluids, and the fluid in the cavities, is imbibed by the absorbing mouths of the lymphatics on the surface of the membranes; but where is the analogy

logy between this and the destruction of solid parts? It has been said that the absorbents eat down the solids, and nibble like the mouth of a worm! a conjecture, the falsity of which is equal to its apparent absurdity. The solids are raised by the agency of the vessels on the chemical affinities of the circulating fluids. They must be resolved by their decomposition, reducing them again to the state of fluids; or the secreting vessels throw out fluids which dissolve them: an operation anterior to their absorption. From the comparative simplicity of the fluids of the circulating vessels, and that in the absorbents, we are authorized to conclude, that as from the blood the several secretions, solids, and fluids are formed; these fluids, before they are again taken into the active system of vessels, are resolved into their original simple and constituent parts. Thus we are not to look for the matter of the component parts of the body in the absorbing system of vessels more than in the blood, from which these parts were originally formed.

Upon this subject I conceive, that the absorption of the solids depends but in a limited degree on the agency of the lymphatics; and that there is a necessary change in the aggregation of the matter previous to the absorption by the mouths of the lymphatic vessels.

#### EXAMINATION OF SOME OPINIONS OF MR. HUNTER ON THE SUBJECT OF ABSORPTION OF SOLIDS.

MR. HUNTER says that his conception of the matter is, that nature leaves little to chance; and that the whole operation of absorption is performed by an action in the mouths of the absorbents. Physiologists have

laboured, he observes, to explain absorption on the principle of capillary attraction, because it was familiar; but as they were still under the necessity of supposing action in the vessels after the matter was absorbed, they might as well have carried this action to the mouths of these vessels.

One never could have ventured to suppose the extravagant conclusion to which this idea, once entertained, has led Mr. Hunter.—He proceeds to consider the many kinds of solids the lymphatics have to carry away, and the variety of mouths in different animals, suited to the great variety of substances they have to work upon, and then draws the conclusion, or leaves his reader to do so; that not only are the mouths of the lymphatics calculated to absorb fluids; not only do they carry away the solids, but each vessel, according to the hardness and toughness of the material upon which it has to operate, has a mouth adapted for the work. Here we do not see the genius of Hunter, but a poverty of imagination.

Mr. Hunter takes the merit of a new doctrine relating to absorption.—He admits that oil, fat, and earth or bones had always been considered as subject to absorption; and that some other parts of the body liable to waste had been supposed to suffer by absorption; but that any solid part should be absorbed, he supposes to be entirely a new doctrine.—Now, I think we may venture to affirm, that not only was it known that solid parts of the body were taken away during life; but that physiologists knew each and every part of the living body to be undergoing a perpetual decay and renovation. Nay, we may venture further to say, that Mr. Hunter did not comprehend, in its full extent, the

the relation in which the secreting and absorbing vessels stand to each other. He is fond of calling the absorbents, modellers,—“modellers of the original construction of the body,”—“modellers of the form of the body while growing.” No doubt he understood that such terms from their novelty would be acceptable to minds incapable of real conviction, or of receiving or appreciating a new fact or idea. Mr. Hunter could contemplate no change in the body during growth, decay, or disease, where there was an alteration of form or quantity of matter, without attributing it to the “modelling absorption.”—A bone cannot be removed without absorption; nor a part which is useless to the œconomy (as the alveoli of the teeth, the ductus arteriosus, the membrana pupillaris, the thymus gland) diminished in size or totally carried away, without the absorbents being in action. This is undoubtedly true; but in regard to the manner in which it is performed we cannot agree with Mr. Hunter. When it becomes necessary that some part should be removed, it is evident that nature, in order to effect this, must not only confer a new activity on the absorbents, but must throw the part to be absorbed into such a state as to yield to this operation. This is the only animal power capable of producing such effects; and like all other operations of the machine, it arises from *stimulus* or irritation. &c. Now, this appears to be the fundamental error of Mr. Hunter’s doctrine. I conceive that the absorption of parts in the natural action of health or in disease, is not owing to increased stimulus, but often to a diminution of it.

Does it not strike us forcibly that when a gland swells, and leeches and blisters are applied, and it subsides,



subsides, there can be no means of exciting absorption ; that when pressure is made on a part, and that part is absorbed, this is a strange way of stimulating ? Or when we bleed, is it not odd that this should give new power to the lymphatic system ? for these are the means of giving a counter irritation, and of suppressing action.

Mr. Hunter has given to the lymphatics not only the grovelling qualities of animals, as eating ; but the higher attributes of intellect. They do nothing without forethought and intention ; when they absorb, it is because they have found the parts useless in the œconomy. He has carried this notion so far, that he does not only speak of the absorption of the thymus gland, membrana pupillaris, alveoli of the teeth, &c. ; but of the body in fever as a consequence of its becoming useless when under disease !—The following may perhaps appear to be the more natural supposition :

In a living body we may observe the agency of the nervous, vascular, and absorbing systems : and the phenomena of life are not to be attributed to any one, but to the whole of these. We must also observe, that life, or the mutual action of parts producing the phenomena of life, is proceeding from excitement, and as in the whole system, so in the individual parts of the body, the healthy action depends on the influence of this excitement to action. The tendency of the growth of the body to peculiar forms, and the increase of parts in disease are produced by it. It acts upon the vascular system in disease, by producing increased action and secretion ; as a muscle, in the use of frequent and strong action, will become more fleshy and vascular ; as a gland, will be excited to greater  
action

action and more profuse discharge, whilst it enlarges and swells up. When a part enlarges in consequence of the stimulus to increased action, either arising from the natural law of the constitution or from disease, it proceeds from the secreting vessels preponderating over the absorbing vessels. There is a deposition of matter which the latter are unable to take away. But diminish this action of the arteries, or take away their excitement, or cause an excitement of some neighbouring part, and thereby subdue their action, relieve them of their fulness, and the absorbents regain their proportioned actions, and the part subsides. The parts of the body, which, in the natural changes from youth to age, are absorbed and carried away, are those in which there is no longer the stimulus to vigorous action, and of course the lymphatics preponderate over the power of the secreting vessels, and the part gradually diminishes, loses its apparent vascularity, loses its redness, and is at last totally absorbed. And as the tooth of a child lies long hid under the jaw, where it partakes of the stimulus to the action of its vessels, grows, and rises up, and the alveoli, partaking of this natural excitement, also form around it ; so when the tooth decays and falls out, the alveoli will also decay and be absorbed ; because the moment these vessels have ceased to partake of the increased action, their absorbents, though acting with no greater powers than formerly, do yet so preponderate, that a gradual wasting is the consequence. Thus we have to consider not the action of the absorbents merely, but the relation which their action has to that of the arteries.

I would

I should conclude that a part which has ceased to be of use in the œconomy and is absorbed, has not been carried away by the stimulus applied to the modelling lymphatics; but in consequence of a want of the usual excitement of the parts to action, and of the consequent preponderance of the action of the lymphatics; not by an increase of their action, but by a greater uniformity of action, less dependent on the state of excitement of the part. This more uniform state of action, or lesser degree of dependence on excitement, will not be denied when we see them continuing their action after the death of the animal, and after the other phenomena of life have ceased. As to the absorption of the body in general from disease, as in fever, it appears to be simply the effect of the continued absorption, while neither the organs for digesting and assimilating new matter, nor the vascular system for conveying the fluids, are in a state to minister to the wants of the system, but suffer under an unusual irritation, which disorders their function.

As to pressure causing absorption and producing the wasting of parts, I cannot agree with Mr. Hunter in supposing that the lymphatics are here excited to action; but should rather infer that the nerves of the parts being benumbed, and the action of the arteries suppressed, the lymphatics continue to do their office, while the arteries are prevented from depositing new matter.—For example, when we see a curvature of the spine, from a habitual inclination of the body to one side, and consequently greater pressure on the one side of the bodies of the vertebra:

it is natural, at first sight, to say, since the one side of the vertebra is of its natural depth, and the other diminished, that the side which is deep has remained, but the other side has been absorbed; but, when we inquire a little deeper into the phenomenon, which has taken place, we recollect that the matter of bone is undergoing a perpetual change, and that the matter of both sides of the vertebra is changed; we see that the pressure may not have excited the vessels to greater action so as to cause absorption; but that the pressure has prevented the deposition of new matter, when the old was taken away in the natural routine of the system.

Mr. Hunter has assigned five causes of absorption; which I conceive may be very naturally resolved into one.—These are, 1, parts being pressed; 2, parts being irritated; 3, parts being weakened; 4, parts being rendered useless; 5, parts becoming dead: of the first we have already spoken; the second I should deny, unless when it resolves into the third; for irritation does not cause absorption, unless when it is to an extent sufficient to destroy the natural action and weaken the part. The third and fourth come under the effect of the loss of the natural and accustomed stimulus to action in the arterial system, which of course gives a preponderance to the absorbents: of the fifth we can have nothing to add illustrative of the living system.

C H A P. II.

OF THE COURSE OF THE LYMPHATICS.

**T**HE lymphatics, in their course and relation to the fascia and muscles of the extremities, bear a great analogy to the veins ; for there are two sets or grand divisions,—the DEEP LYMPHATICS which accompany the arteries in their branchings amongst the muscles ; and the SUPERFICIAL set which accompany the external veins.

SECTION I.

OF THE FOOT, LEG, AND THIGH. Even in the toes the same distinction of the origins of the lymphatics may be observed, as in the limb. For while a plexus covers the toes superficially, and runs up upon the foot with the veins, deeper branches accompany the arteries on the side of the toes. When we observe the course and origins of the greater and lesser saphena vein, we cannot fail to understand the course of the several sets or divisions of the lymphatics of the foot and legs.

From the toes, dorsum, and edges of the foot, the lymphatics climb up the leg in four classes. 1. One takes a course from the root of the great toe and inside of the foot, over the tendons of the great toe and tibialis anticus tendon. It then passes on the inside of

the tendon of the tibialis anticus muscle, and before the head of the tibia, following the principal branch of the great saphena vein; and then continues its course in company with the saphena to the inside of the knee.

2. There is at the same time a considerable number of lymphatics, taking their origin from nearly the same place, viz. the inside of the foot, and before the inner angle; but they take a different course on the leg from the last class; for they pass behind the lower head of the tibia: they now attach themselves to some branch of the saphena vein, and join the former set on the inside of the knee. From this they ascend superficially above the fascia to the glands of the groin. 3. From the outside of the foot there ascend several lymphatics; a division of which passes before the outer angle and across the tibia to join the lymphatics, parasites of the great saphena vein, and here they sometimes form plexus and contortions; others turn in behind the outer angle, and join the branches accompanying the lesser saphena.

The lymphatics which turn round behind the outer angle pass on the outside of the tendo achillis; and accompanying the lesser saphena vein, sink into the popliteal hollow. Here they unite with the lymphatics which have accompanied the several arteries of the leg and foot, and particularly the posterior tibial artery.

**POPLITEAL GLANDS.** The glands of the ham-string cavity are generally three in number, and very small. They receive the lymphatics, which pass with the internal tibial artery and with the lesser saphena, and they of course swell and become inflamed in consequence of sores on the calf of the leg, outside of the foot, and sole of the foot.

From

From the popliteal glands there ascend two large lymphatics, which accompany the popliteal artery and venæ comites, and ascend with the latter through the adductor magnus to the fore part of the thigh. They run irregularly, or form a kind of network round the great vessels. On the fore part of the thigh, and still deep, they (or at least some of the principal trunks) enter the lower and deep inguinal glands, or emerging, they pass into the outward glands of the groin. Sometimes these deep lymphatics, instead of being accumulated into larger trunks, divide into many branches, and only unite in the glands of the groin.

**INGUINAL GLANDS.** The inguinal glands are in number from five to ten; they lie involved in cellular membrane on the outside of the femoral ligament. Some of them are superficial and moveable under the integuments; some involved in the laminæ of the fascia, descending from the abdominal muscles; some are close on the femoral artery and vein, and under the fascia. Nearer to the pubes may be observed a division of these glands which belong to the lymphatics of the penis, perineum, &c.

The greater cluster of glands on the top of the thigh becomes affected from disease of the integuments on the fore part and inside of the thigh and leg; and of that part of the foot where the great saphena vein commences; nay, further, the inguinal glands swell from sores of the buttocks, about the anus and private parts. They will even swell from disease of the testicle; but this only by sympathy.

**LYMPHATICS OF THE PARTS OF GENERATION IN BOTH SEXES.** From the penis there run backwards

two sets of lymphatics : superficial ones, which take a course to the groin ; and deeper ones, which take a course along the arteries of the penis into the pelvis, or under the arch of the pubis. The superficial lymphatics are the cutaneous vessels, and take their origin from the prepuce, and it is these which, either absorbing the venereal matter of chancre, or sympathizing with the venereal action, form sometimes an inflamed line along the penis, and cause the buboe in the groin. But as there are two sets of lymphatics, the chancre may be in a place where the deep-seated vessels are the absorbents, and consequently the constitution is contaminated without any buboe in the groin ; and indeed it has been observed, that a venereal ulcer of the prepuce will, in general, produce buboe, when an ulcer of the glands will not \*. When the tract of the matter is through the deep lymphatics which enter the pelvis from below, the gland through which the vessels pass, is not inflamed to form a buboe ; neither do the lymphatic glands within the ligament of the thigh inflame to the extent of forming a buboe, either from chancre or from buboe in the groin. This, says a celebrated anatomist, Mr. Cruickshanks, is very fortunate ; for if the external iliac glands, like the inguinal glands, should suppurate, they could not be opened by the lancet, they must be left to themselves ; they might burst ; the pus might fall into the cavity of the abdomen ; might produce peritoneal inflammation ; and might probably destroy the patient. Now, there appears no reason to dread any such catastrophe. The matter of these glands would form an abscess, which,

\* Cruickshanks, page 138.



like other abscesses in the track of these vessels, would fall down upon the thigh. The fact, however, is curious; that when the lymphatics diseased enter one set of glands, there will be no buboe; when they take a course to the other, they inflame and suppurate. This I believe may be explained, from considering the position of the inguinal glands, as being immediately under the skin: for experience shows that a part near the surface will inflame and proceed to suppuration much more readily than a part deep seated, though suffering from the same degree of excitement.

In the external parts of woman (by Mr. Cruickshanks's observation) there are also two sets of lymphatics. Those near the clitoris pass up in a direction to the ring; and those from the lower part of the vulva and perineum to the glands of the groin.

**LYMPHATICS AND GLANDS WITHIN THE LIGAMENT OF THE THIGH.** The vasa efferentia of the inguinal glands are in number from two to six. The deep lymphatics which accompany the femoral vein and artery, lying under the cellular membrane, pass under the ligament, and soon form a large network of vessels accompanying the iliac vessels, in which they are joined by the branches of lymphatics from the superficial glands; sometimes the trunks accompanying the great vessels of the thigh pass into a gland, immediately within the ligament; sometimes one or two of them only enter into the glands high in the loins; nay, sometimes a large vessel passes on directly to the thoracic duct.

From six to eight or ten glands are seated in the tract of the external iliac vessels, under the name of **EXTERNAL ILIAC GLANDS.** And upon the inside of the

the brim of the pelvis, and on the hypogastric vessels, the glands are called the INTERNAL ILIAC GLANDS. In proportion to the frequency of disease in the pelvis, these external iliac glands, being in the tract of the lymphatics of the private parts and rectum, &c. are particularly subject to disease. Those glands also which are called SACRAL GLANDS, as lying on the meso-rectum, and in the hollow of the sacrum, have been observed to be often diseased. On the psoas muscle, and on the loins it is impossible to trace the vessels as single trunks; we may observe that one net-work of vessels ascends upon each psoas muscle from the thigh; that there it is joined by the lymphatics of the pelvis. These vessels are in a manner united by those which cover the prominency of the sacrum, and pass under the bifurcation of the aorta. The two GREAT LUMBAR plexus of lymphatics continuing their ascent, many of the vessels enter into the lumbar glands; and on the loins they are joined by the absorbents of the testicle. By the union of the lymphatics ascending from the right and left side, with several large trunks of the lacteals from the root of the mesentery, the thoracic duct is formed on the third and fourth vertebra of the loins.

## OF THE LYMPHATICS OF THE ARM.

IN the arm, as in the leg and thigh, there are two sets of lymphatics:—the superficial and deep seated. The first of these accompany the cutaneous veins, the latter the deep arteries.

As in general there are two great veins on the fore arm, the basilic and cephalic veins; but particularly as the veins which gather into the basilic trunk, on the inner and lower edge of the fore-arm, are the larger and more numerous class; so it is found that the course of the more numerous class of lymphatics is on the lower and inner side of the fore arm, and that they accumulate about the basilic vein. These are derived from the palm of the hand, and from the ulnar edge of the hand. This set sometimes passes into glands, seated on the brachial artery, near the inner condyle of the humerus.

The absorbents which accompany the cephalic vein, arise from the sides of the thumb and fore finger upon the back of the hand; they run on the radial edge of the arm, with the veins which ascend to form the cephalic vein. From the bend of the arm these vessels take a course on the outer edge of the biceps, and then get betwixt the inner edge of the deltoid, and outer edge of the pectoral muscles; they then pass under the clavicle, and descend into the axillary glands. This set of absorbents receive the branches from the outside of the arm in their whole course.

There are absorbents arising from the back of the hand, next the little finger, which following some of the branches of the basilic vein (a larger branch of which is called the ulnaris externa) turn round the ulnar edge of the arm, are inserted into a gland, very commonly found before and a little above the inner condyle of the humerus. From this gland a large lymphatic passes upwards, and attaching itself to the brachial artery, splits and plays around it.

The

The deep-seated lymphatics of the arm accompany the arteries in the same manner as the *venæ comites* do; in general two with each artery. They all terminate in the glands of the axilla, and can require no particular description. The lymphatics, from the muscles and integuments on the back of the shoulder, also turn round and enter into the glands of the axilla.

The GLANDS OF THE ARM are small, and irregularly placed in the course of the humeral artery, from the condyle to the axilla. They are from three to six in number.

The GLANDS OF THE AXILLA are large and numerous; they receive the lymphatics from the arm, breast, and shoulder\*; they lie in the deep cavity of the axilla, formed by the tendons of the *pectoralis major*, and *latissimus dorsi* muscles. They are imbedded in a loose cellular membrane, which, while it surrounds and supports the vessels of the axilla in the motions of the joint, gives them strength from its elasticity. These glands do not all surround the axillary artery; but a lower cluster is attached to the branches of the subscapular artery, going forward on the side of the chest, and to the thoracic arteries. These it is which, indurating from cancer of the breast, require so frequently to be extirpated. These glands of the axilla greatly enlarging close upon the artery and plexus of nerves, so as to preclude the possibility of an operation; they compress the veins and benumb the arm by pressure upon the nerves. When they suppurate, they cause a

\* "They even receive absorbents from the cavity of the chest and I have known them swell from pleurisy, peripneumony, and pulmonary consumption." Cruickshanks.

### 322 OF THE COURSE OF THE LYMPHATICS.

condensation of the cellular membrane which surrounds them, and in consequence, a compression of the axillary nerves and a shrinking of the arm.

When a wound or puncture, such as that which the student of anatomy may receive in the dissecting room, has been made on the little or ring finger, the red lines which often appear in consequence of it, have taken the course of the ulnar edge of the fore arm, and terminated in the inside of the arm, near the condyle; in some instances they have been continued even into the axilla. If venereal matter is absorbed at any point of the hand, near the little or ring finger, or by those fingers, the gland on the inner condyle of the humerus, or some one in the course of the brachial artery, will most probably inflame and form a bubo, and the surgeon will be aware of this absorption; but if the venereal matter be absorbed on the thumb or fore finger, it is possible that it may not pass into the glands until it comes into the inside of the clavicle. These glands being out of our sight and feeling, the patient may be infected without the surgeon suspecting it\*.

#### LYMPHATICS OF THE HEAD AND NECK.

Of the absorbents of the brain, little is known precisely; but none can deny the probability, next to an absolute assurance and demonstration, that the arteries, veins, and lymphatics bear the same relations in the brain as in the other parts of the system. Lymphatic

\* Cruickshanks, p. 182.

glands are observed in the course of the internal jugular vein, and even in the foramen caroticum, which are understood to belong to the lymphatics of the brain. The lymphatics of the head are to be observed in the course of the temporal and occipital arteries, which last terminate in glands, seated behind the mastoid process of the temporal bone. The lymphatics of the face have been observed very numerous accompanying the facial and temporal arteries. But those from the internal parts of the face and nose accompany the internal maxillary artery, and fall into the glands under the parotid, or in the course of that artery. These glands are consequently liable to disease, in consequence of absorption of matter from the face, throat, and nose, and their extirpation is a very hazardous operation. The lymphatics from the gums and jaws also accompany the internal maxillary artery, and emerge under the angle of the jaw; and some of them joining the external jugular vein, pass through glands near the top of the shoulder. The lymphatic vessels from the tongue and parts about the os hyoides, take also the same course. The GLANDS about the FACE and JAWS are of the greatest importance to the surgeon, for nothing is more common than the necessity of cutting out indurated lymphatic glands. These are sometimes mistaken for diseased salivary glands; now the salivary glands are rarely diseased, the lymphatic glands often. And it will be a guide to the surgeon to inquire into the original cause of the induration, (perhaps a suppuration in the throat, nose, or jaws) and to know precisely the gland diseased, its depth, and connections.

On the side of the face, there are in general several small lymphatic glands on the buccinator muscle immersed in the surface of the parotid gland, under the zygomatic process. There are also glands to be carefully noted, which lie under the tip of the parotid gland, where it extends behind the angle of the jaw, and also lying under the base of the jaw-bone, close to the sub-maxillary gland, and on the course of the facial artery.

The GLANDS and ABSORBENTS of the neck are very numerous, and the latter form an intricate and beautiful plexus, several branches of which are to be observed accompanying the external and internal jugular veins. Some of the glands lie immediately under the skin, and in the cellular membrane, on the outer edge of the platysma myoides; many under that muscle, and in the course of the external jugular vein. But there are many seated deep, for the greater number accompany the internal carotid artery, and internal jugular vein or their branches.

The lymphatics of the THYROID GLAND have been raised by Mr. Cruickshanks, by plunging a lancet at random into the substance of the gland, and blowing into it, or throwing quicksilver into its cellular membrane. The trunks of these lymphatics join the thoracic duct on the left side; and on the right side the right trunk, just as it is about to enter into the veins,

#### OF THE TRUNKS OF THE ABSORBENT SYSTEM.

THE larger and proper trunk of the lymphatic system, is generally called the THORACIC DUCT, because

it

it was first observed by Pecquet \* to be a vessel which conveyed the chyle through the diaphragm, and which took its course through the whole length of the thorax, to throw its fluids into the veins near the heart. Before his time the lacteals which were discovered by Asellius †, were supposed to terminate in the liver. The first discoverers of the thoracic duct, described it as beginning from a pyriform bag, to which they gave the name of RECEPTACULUM CHYLI. In dogs, fish, and the turtle, such a cistern or bag may be observed; but in the human body nothing further is to be observed than an irregular dilatation of this vessel, like a varicose distention, where it receives the accession of the lacteals from the root of the mesentery. The origin of this great trunk, called the thoracic trunk, is the union of the vessels, which running by the side of the common iliac vessels, are derived from the pelvis and lower extremities. Upon the third and fourth vertebræ, and under the aorta this trunk is frequently joined by a large trunk of the lacteals, and then ascending, it receives the greater number, or the larger trunks of the lacteals. On the vertebræ of the loins, the thoracic duct is by no means regular, either in its course or size or shape; often it contracts, and again irregularly dilates, as it seems to emerge from under the aorta. On the uppermost vertebra of the loins, the thoracic duct lies under the right crus of the diaphragm, and then passing the septum with the aorta, it gets on the right anterior surface

\* In the year 1651.

† In the year 1622. — About the year 1652, the other branches of the system, which take their course to every part of the body, were discovered by Rudbeck, Jolyffe, and Thom. Bartholin.



### 326 OF THE COURSE OF THE LYMPHATICS.

of the spine, and runs up betwixt the aorta and the vena azygos; it then passes under the arch of the aorta, and there it is considerably enlarged, from the contracted state which it assumes in the thorax. Sometimes it splits, and again unites on the vertebræ of the back. Having passed the arch of the aorta, it crosses to the left side of the spine, and we look for it under the pleura on the left side of the œsophagus.

The thoracic duct now emerges from the thorax, and lies deep in the lower part of the neck, behind the lower thyroid artery, and on the longus colli muscle.

It gets above the level of the subclavian vein of the left side, and here it receives the absorbents of the head and neck (of the left side), and descends again with a curve, and terminates in the angle of the union of the subclavian vein and jugular vein of the left side.

Sometimes there are two thoracic ducts; but this is very rare. Sometimes the duct splits near its termination, and the two branches enter the veins separately; but, in general, when it splits in this manner, it again unites before it terminates in the vein.

It There is constantly a trunk in the anterior mediastinum under the sternum, as large as the thoracic duct itself, which is sometimes inserted into the termination of the thoracic duct; sometimes into the trunk of the absorbents of the ~~left~~ side, to be immediately described\*.

#### THE TRUNK OF THE ABSORBENTS OF THE RIGHT SIDE.

THE absorbents, from the right side of the head and neck, and from the right arm, do not run across the

\* Cruickshanks.

neck,

neck, to unite with the great trunk of the system ; they have an equal opportunity of dropping their contents into the angle betwixt the right subclavean and the jugular vein. These vessels then uniting, form a trunk which is little more than an inch, nay, sometimes not a quarter of an inch in length, but which has nearly as great a diameter as the proper trunk of the left side.

This vessel lies upon the right subclavean vein, and receives a very considerable number of lymphatic vessels : not only does it receive the lymphatics, from the right side of the head, thyroid gland, neck, &c. and the lymphatics of the arm ; but it receives also those from the right side of the thorax and diaphragm, from the lungs of this side, and from the parts supplied by the mammary artery. Both in this and in the great trunk there are many valves.

#### OF THE LACTEALS AND LYMPHATICS OF THE INTESTINAL CANAL.

WE have already remarked the great length of the intestinal canal, the effect of the imperfect valvular structure, in extending the inner coat to a great length ; we have remarked also, that while every surface of the body secretes, it is at the same time an absorbing surface ; and finally, that while we chiefly contemplate the intestinal canal, as imbibing and receiving the nourishment, we must not forget that it is also a secreting surface of the first importance to the œconomy. But at present we have merely to understand that structure and organization, by which this canal absorbs the nutritious fluid the chyle from the food.

In

In the first place, as to the terms lacteals and lymphatics, we presume that the absorbents throughout the whole length of the canal have the same structure and use; and that the term lacteals has been suggested merely by the colour of the fluid, which is absorbed from the small intestines. At one time these lacteals convey a milky fluid: at another a transparent fluid, like that which the stomach and great intestines in general absorb.

The lacteals, as it is natural to suppose, were the first discovered of any part of the system of absorbents; or, at least, they were first understood to form a part of an absorbing system. For although Eustachius, a Roman anatomist, discovered the thoracic duct in the year 1563, yet he had very imperfect notions of its importance, and the discovery was very little attended to, till after the discovery of the lacteals by Asellius in 1622. This anatomist, in opening living animals, to observe the motion of the diaphragm, observed white filaments on the mesentery, which he took at first for nerves; but, on puncturing them, and observing them to discharge their contents and to collapse, he proclaimed his discovery of a new set of vessels—a fourth kind\*.

Had Asellius only chanced to observe these vessels, his merit would have been inconsiderable; but he also investigated and announced their peculiar office, viz. of absorbing the chyle from the intestinal canal, and carrying it into the blood.

For some time, however, after the discovery of the vasa lactea, the opinion of Hypocrates and Galen,

\* The nerves being counted as vessels.

viz.

viz. that the mesenteric veins absorbed the chyle from the intestines, and conveyed it to the liver, still prevailed. Even after the discovery of the lacteals was known and received, a part of the old system was still retained, and it was supposed that those vessels carried the fluids absorbed from the intestines into the liver; and that the fluids were there converted into blood.

About twenty years after the discovery of Asellius, Rudbeck, a Swede, and Bartholin, a Danish anatomist, saw Asellius's vessels in many other parts of the body; discovered the trunk of the system, and showed that the lacteals did not pass to the liver, but that they were branches of a great and distinct system; they also demonstrated the unity of this system.

We have seen from this sketch that the ancients supposed the veins of the intestines to be absorbents; and even after the discovery of the lacteals, this idea has been retained by some of the best modern anatomists, and principally by Haller, and professor Mickel of Berlin. If the veins absorb from the surface of the intestines, their doctrine would imply that they are also absorbents in general throughout the body. Although Bartholin, in his epistle to Harvey, had asserted and given sufficient proof that the mesenteric veins were not absorbents, yet the controversy was left in so undecided a state, as to give occasion to the series of experiments in the school of the Hunters, which seems to have put the question to rest, in as far as it is connected with the lymphatic system\*.

We have already mentioned that Asellius was employed in opening the belly of a living dog, when he

\* See the VEINS in this volume.

first discovered the lacteals. He perceived upon the surface of the intestines and mesentery a great many small threads, which, at first sight, he took for nerves, but soon discovered his error; and to dissipate his doubt, opened one of the largest white cords, when no sooner had the incision been made, than he saw a fluid like milk or cream issue from the vessels. Asellius says he could not contain his joy at the sight of this phenomenon; and turning himself to Alexander Tadinus, and the senator Septalius, who were present, he invited them to enjoy the spectacle;—but his pleasure, he adds, was of short duration, for the dog died, and the vessels disappeared. The natural and simple narration of Asellius represents his astonishment, and gives an idea of the sensation, which the anatomist experiences in the instant of making an interesting discovery\*.

ORIGIN OF THE LACTEALS. When the young anatomical student ties the mesenteric vessels of an animal recently killed, and finds the lacteals gradually swell; when he finds them turgid, if the animal has had a full meal, and if he has allowed time for the chyle to descend into the small intestines—and empty, or containing only a limpid fluid if the animal has wanted food; he has sufficient proof that these are the vessels destined to absorb the nutritious fluids from the intestines. Again, when coloured fluids are thrown into the intestines of a living animal, and they are absorbed, he has sufficient proof of their free and ready communication with the inner surface of the gut; but the actual demonstration of the absorbing mouths of the

\* Sheldon, Portal.

lacteal vessels is difficult and precarious. The difficulty arises from these vessels being in general empty in the dead body; from the impossibility of injecting them from trunk to branch in consequence of their valves; and, lastly, from their orifices never being patent, except in a state of excitement. The anatomist must therefore watch his opportunity when a man has been suddenly cut off in health, and after a full meal. Then the villi of the inner coat may be seen turgid with chyle, and their structure may be examined. Perhaps the first observations which were made upon this subject by Lieberkuhn, are still the best and the most accurate.

The villi are apparently of a cellular structure, for although they are flat or conical, or like filaments when collapsed; yet when minutely injected, and especially when they are full of chyle, they take a globular form, and are called the AMPULULÆ. Their distention, in consequence of a minute injection of the veins or arteries, is probably owing to a cellular structure (which they seem to have) into which the injection has extravasated. The most probable account of the structure of these ampululæ is that this cellular structure is a provision for their inflation and erection by the blood, when excited by the presence of the chyle in the intestines; that this erection gives rigidity to the orifice of the lacteals; and that the first step of absorption is by capillary attraction, while the further propulsion of the fluid in the extreme absorbents is by the contraction of their coats excited by the presence of the fluid. Thus the absorption is not by an inorganized pore, but depending on excitement and action.

Lieberkuhn's observations of the villi are the most accurate and curious. He observes, that having opened and washed a portion of the small intestine, its whole surface will be found covered with little pendent conical membranes of the fifth part of a line in size, and the bases of which almost touch each other. From the vascular membrane, to which they are attached, he observes there is given off to each villus a branch of a lacteal, an artery, a vein, and a nerve. He found it difficult by injection to show both the vein and artery, the fluid passed so easily from the one into the other. He found that the extreme branch of the lacteal was distended into a little vessel within the villus. And on the apex of which, with the microscope, he saw one or sometimes several openings; with his glasses he observed the arteries to ramify on the globules or ampullæ and again collect into veins; and he supposed that still more minute branches plunged into the centre. But he made a still more minute observation than this. Isolating a piece of intestine betwixt two rings, only leaving a space for the entrance of the ramification of the artery which supplied it, he injected with a column, and examined its progress at the same time with his microscope. As he raised the tube, he saw the artery going in serpentine turns to the villus, and the injection returning by the veins; at last it passed into the ampulla lactea, distended it and made its exit by the foramina. He prepared the villi in another way:—he inflated the ampullæ, and kept them so until they dried; then he cut them with a razor, and found them cellular. This cellular structure Cruickshank thinks is the common cellular substance, uniting the vessels of the villus. When this  
gentleman

gentleman examined the villi of a patient who died suddenly after a meal, he observed some of them to be turgid with chyle, so that nothing of the ramifications of the arteries or veins were to be observed; the whole appeared as one white vessel without any red lines, pores, or orifices; others of the villi contained chyle in a less proportion; and here the ramifications of the veins were numerous, and prevailed by their redness over the whiteness of the villi.

In some hundred villi he saw the trunk of a lacteal forming by radiated branches, one branch in each villus. Mr. Cruickshank and Dr. Hunter counted fifteen or twenty orifices in some of the villi.

Mr. Cruickshank has remarked a deep and a superficial set of lacteals on the intestines; but for this division there seems no necessity. Deep in the coats the lacteals seem to accompany the blood vessels; but when they get more superficial, they take a course longitudinally on the canal, and turn deviously, or after running a little way, take a sudden turn towards the mesentery.

As the greater frequency of the *valvulae conniventes* in the jejunum, greatly encrease the extent of its inner surface of the gut, and consequently give a greater extent of origin to the lacteals; and, as here the chyle must be in the greater quantity, so the lacteals of this portion of the gut are larger and more numerous than in any other part of the extent of the canal.

The lacteals do not attach themselves to the vessels of the mesentery, but take a course individually, or forming plexus. Before they enter the mesenteric glands, they have been called lacteals of the first order;



when they emerge from the first into the second glands, secondary lacteals, and glands of the second order. The manner of the entering and going out of glands is exactly the same with that of the lymphatics. The lacteals (or perhaps we should now say the absorbents merely) of the great intestines, are smaller and less numerous than those of the small intestines; for although the intestines be large, still their inner surface is by no means so extensive: besides the chyle is absorbed, and the contents altered before they have descended into the great intestines. Both Winslow and Haller, however, assert, that they have seen chyle in the absorbents of the great intestines. We know that the lacteals absorb chyle, when it is presented to them: while at other times they absorb different fluids. That the absorbents of the great intestines imbibe the fluids contents is evident, from the change produced on the feces in their passage. Copious and nutritious injections have been given, which did not return in the same liquid form, and which have supported the strength for some time. Clysters of turpentine give the urine a smell of violets; and the Peruvian bark has cured fever, when given by the rectum.

The absorbents of the stomach form three divisions: one set accompany the coronary artery and vein, and enter the glands on the lesser curvature and omentum minus. Those of the second set accompany the left gastro-epiploic artery, and are joined by the lymphatics of the omentum. The third pass down upon the upper part of the duodenum following the arteria gastrica dextra: these descend to pass into the same class of glands, which receive the lymphatics of the liver.

liver. They are joined in their course by the lymphatics of the right side of the omentum.

The lacteals on the mesentery pass from one gland to another till they form one or two large trunks only. These accompany the trunk of the superior mesenteric artery, and run down on the right side of the aorta, and join the thoracic duct. The absorbents, from the rectum and colon of the left side, pass into their glands, or sometimes into the lumbar glands, and join the thoracic duct separately; those from the right side of the colon join or mingle with the lacteals in the root of the mesentery.

OF THE REMAINING ABSORBENTS OF THE SOLID  
VISCERA.

Where the lymphatics of the lower extremity descend over the brim of the pelvis, they are joined by the absorbents of the bladder, vesiculæ feminales, and other parts in the pelvis:—small glands belonging to this set are attached to the internal iliac vessels. In the female, the lower set of lymphatics, from the womb and vagina, also come by this route to join those of the lower extremity, or run mingling with them. Another set of lymphatics of the womb pass up with the spermatic vessels.

The lymphatics of the TESTICLE are very numerous. They come in distinct sets from the body of the testicle, from the epididimis, and from the tunica vaginalis: then reaching the cord, form six or ten trunks, and run up direct to the abdominal ring; passing the ring,

they turn outward, and then pass over the psoas muscle and into the lumbar glands.

The lymphatics of the KIDNEY are in two sets, superficial and deep seated; but the former are seldom to be observed. Sometimes disease makes them distinct. The internal lymphatics are demonstrated by blowing into the veins, or tying a ligature and kneading the substance of the kidney with the fingers; when they rise, they are seen attached to the emulgent vessels, and go to join the lumbar glands, or terminate in large lymphatics near the aorta.

It is needless to repeat that the absorbents of the spleen are deep and superficial,—for this arrangement is general. Emerging from the spleen, the lymphatics pass alongst the splenic vessels, and enter into glands attached to the splenic artery in its whole course. In this course they receive the absorbents from the pancreas, and near the head of the pancreas, they are blended with those of the liver, and with them join the thoracic duct.

The lymphatics of the liver are the most easily detected, and may be injected to greater minuteness, than in any other part of the body. Although they have many valves, yet they do not seem to close the vessels intirely, nor interrupt the mercury from passing from trunk to branch. The superficial lymphatics, which are so numerous that we may sometimes see the mercury in them covering completely a considerable space, have free communication with the internal set of vessels which are also numerous and large. The principal route of the lymphatics of the upper surface of the  
liver,

liver, is by the broad ligament : these perforating the diaphragm join the trunk, which we have noticed under the sternum, and in the anterior mediastinum. It would appear, however, that these lymphatics of the broad or suspensory ligament, are by no means constant and uniform in their course ; for some times they run down towards the lacteal ligament, and perforate it there ; some times they pass down into the thoracic duct while still in the belly. Other lymphatics of great size, run off from the convex surface of the liver upon the lateral ligaments, and pierce the diaphragm. The lymphatics on the lower or concave surface of the liver are more irregular than those of the convex side. They unite with the deep lymphatics coming out of the porta along with the vena portæ, enter into the glands, which are seated on the trunk of that vessel, and join the thoracic duct near the root of the superior mesenteric artery.

The lymphatics of the LUNGS are nearly as numerous as those of the liver ; but, indeed, in regard to this expression, it is more in relation to the facility of injecting and demonstrating the lymphatics, than to their comparative number. For example, if the lymphatics of the other viscera could be injected to as great minuteness as those of the liver, we should cease to consider that viscus as more abundantly supplied than other parts. The superficial lymphatics of the lungs form areolæ, and cover the surface almost completely. They take a course to the root of the lungs, where they are joined by the deep seated vessels, and together pass into the bronchial glands, and here the lymphatics of both sides freely communicate.

The glands of the lungs are constantly found both before and behind the bifurcation of the trachea: often these glands are of a very dark colour; nay, their substance is sometimes found resolved as it were into a sac of inky-like fluid. Upon the arch of the aorta, and the root of its great branches, are the CARDIAC GLANDS, which receive the lymphatics from the heart. The absorbents of the heart are small, but very numerous, and their larger branches attach themselves to the coronary vessels. They then pass to the cardiac glands, and mingling with those from the lungs, join the thoracic duct.

# A P P E N D I X;

CONTAINING THE

DESCRIPTION OF THE VENOUS SYSTEM AND  
THE ANATOMY OF THE TEETH.

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## C H A P. I.

### OF THE VEINS IN GENERAL.

**T**HE veins are those vessels by which the blood carried outward by the arteries, is returned to the heart. The system of the veins however is not so simple as that of the arteries, for while there are only two great arteries carrying the blood from the heart, viz. the aorta and the pulmonic artery, there are three great trunks of the veins, viz. the superior and inferior vena cava, the trunks of the great veins of the body; the pulmonic vein, which returns the blood to the heart from the circulation through the lungs; and the vena portæ, which collects the blood of the intestines, and conveys it to the liver. There are besides, a greater variety in the distribution of the veins, than in that of the arteries.

The French physiologists have departed from the old method of Harvey, in explaining the circulation. He wisely took the heart as the centre of the system, and described the vessels going out from it, forming the two circulations, viz. through the body and through

the lungs; but they have assumed the lungs as the centre; and the veins of the body, and the arteries of the lungs, they call *système à sang noir*, because it contains the dark coloured blood; and the pulmonic veins and the arterial system of the body, they call *système à sangrouge*, because it conveys blood of the bright vermilion colour.

This conceit is perhaps admissible, when introduced as an illustration of the relation of the lungs to the body; but in the general announcing of the system, and considered as a basis of demonstration, it gives to a difficult subject an unusual degree of intricacy in the mind of the young student: besides, the arteries and veins of the body, and the pulmonic artery and vein, have that strict and mutual dependence in action, which shows how improper and how unnatural it is to make this change, and to separate them in explaining the general system. At all events, let those who adopt this novelty cease to speak of the two circulations, for although in regard to the heart, there are two circulations, yet as the movement of the blood respects the lungs, there is only one. By this division, the blood returning from the body and carried into the lungs, cannot be called a circulation; but only when it has passed through the lungs, and returned to the same point of its course through the body.

GENERAL CHARACTER OF THE VEINS.—The capacity of the veins, is larger than that of the arteries; the coats thinner but stronger comparatively, and admitting of much dilatation. The coats of the lesser veins, are comparatively stronger than those of the larger ones, and the veins of the lower extremity much thicker and stronger,

stronger than in the upper parts of the body, as they bear a higher column of blood. The veins are transparent and the blood is seen through their coats. There can be properly distinguished, only two coats in the veins: the outer coat, which is flocculent and cellular without, to connect with the surrounding parts, smoother and more compact within, where it is united with the inner coat. In it are ramified the *vasa vasorum*; and a fibrous structure is to be observed in some of the larger and superficial trunks; the *striæ* or fibres running longitudinally. The inner coat is firm and compact and intimately united to the other; it is smooth, flexible, and formed into valves in various parts.

In all the larger veins, excepting those of the viscera of the abdomen, and those of the lungs and brain, there are valves: these valves consist of the inner coat, forming folds like a semilunar curtain, hung across the caliber of the vein; but at the same time attached so obliquely to the side of the vein, that they present a sacculated membrane to receive the reflux blood. The loose margin of the valve is somewhat stronger than the other part, and betwixt the duplicature some splendid little filaments are sometimes observed. Each valve consists in general, of two semilunar membranes, the margins of which, falling together, prevent the blood from passing retrograde; but they yield and collapse to the side of the vein by the current of blood flowing towards the heart. As the veins are provided with valves only where they are exposed to occasional pressure, and particularly to the compression of the muscles; their chief use would seem to be, to prevent the retrograde movement of the blood, from the occasional  
compression



compression of the veins ; but no doubt, they at the same time support the column of blood, as in the lower extremities : and when those veins suffer distention by disease, a great aggravation is, that the valves lose their action, become too small to close the dilated vein, and the whole column of blood presses upon the veins of the legs.

The commencement of the minute branches of the veins, is from the extreme ramifications of the arteries; they are continuous, and perpetuate the motion of the blood in that course which is called the circulation. In contemplating the capillary tissue of vessels, the most striking circumstance is, the predominance of the dark venous ramifications : and in general, two sets of veins will even in these minute ramifications, be observed ; one superficial, the other more intimately blended with these minute ramifications of the arteries ; but in the internal parts of the body, and particularly the viscera, the veins uniformly accompany the ramifications of the arteries, and in the solid viscera, a dense cellular membrane gives promiscuous lodgement to both sets of vessels.

In the extremities and head, indeed every where but in the viscera, the veins form two distinct sets ; the deep and the superficial veins : the deep veins accompanying the arteries ; and the subcutaneous veins, which emerge from the compression of the muscles, and run above the fascia. The union betwixt the branches of the veins, is very frequent, not only betwixt the veins, ramifying in the same plane in so much as to make them a mere network ; but also betwixt the deep and the superficial set of veins : such are the *venæ emissariæ* of

of the scull ; the free communications betwixt the external and internal jugular vein, betwixt the deep and superficial veins of the arm, &c. When in bleeding, the blood flows from the vein of the arm, accelerated by the working of the muscles, the blood escapes by the anastomosis, from the compression of the muscles, and fills the superficial veins ; but the increase of the jet of blood, is more the effect of the swelling of the muscles, causing the fascia to compress the veins of the fore arm.

In the dead body the veins are flat, but when distended, they resume the cylindrical figure which they possessed in the living body : yet they are in general of the cylindrical figure, for a very little way only, owing to the irregular dilatations by the side of the valves, or by the frequent union of their branches. The manner in which the branches join the trunk, has a peculiarity which always distinguishes it from the ramifications of arteries : the arteries branch off at a direct and acute angle, the veins in a direction more removed from the course of the trunk, and in general with a curve or shoulder.

In infancy and youth, the veins are little turgid, and especially the cutaneous veins, are so firmly embraced by the elastic skin and cellular membrane, that they have a less degree of prominency than in more advanced years. In old age, the veins are enlarged, and rise turgid on the surface, and the internal veins also become enlarged and varicose. I do not consider this change in the vascular system, as the effect of mere distention, or of the enlargement of the veins from the long-continued action of the arteries ; but as a necessary

cessary change in the proportionate distribution of the blood, which is preceded or accompanied with other peculiarities, the character of old age. When we consider the great proportion of the veins in size, over the arteries, we must conclude that the blood flows but slowly in the venous system : that from the narrowness of the trunks of the veins near the heart, the blood must be accelerated, as it approaches the heart, and that receiving the impulse from the ventricle, it must take a rapid course through the arteries, until again approaching the extreme branches of the arteries and passing into the veins, its motion becomes more languid and slow. In youth, as the size of the veins is not in so great a proportion to the arteries, as in advanced life ; the blood in a young person, must be in more rapid and quick circulation : but in old age, in proportion to the largeness of the veins and the accumulation of blood in them, the quantity of blood moving slowly through the venous system, and almost stagnant in the dilated veins and sinuses, is very great ; it moves but slowly and progressively on towards the centre of the circulation ; and upon the whole, the blood in old people, moves less briskly through the vessels, and the proportionate quantity immediately under the influence of the arterial system, is less than in youth.

There is no pulsation to be observed in the veins, but what they receive laterally from the contiguous arteries. There is no pulsation in the veins, because they are removed from the heart ; because they do not receive the shock of the heart's action in their trunk, but only by their widely spread branches ; because the contraction

traction of the heart, and of the arteries so alternate with each other, in such a manner as to keep up a perpetual and uniform stream of blood into the veins ; whereas the pulsation in the arteries is owing to the sudden and interrupted contraction of the heart.

In this general account of the venous system, it remains only to speak of the subject of absorption. Before the suite of experiments made on this subject by Mr. Hunter, a vague notion was entertained that the veins were absorbents ; but about that time\*, the doctrine that lymphatics are absorbents having been established, the opinion that the red veins were also absorbents, was first questioned, and finally confuted, at least in the opinion of most physiologists.

The chief argument to show that veins, arising from cavities, particularly from the intestines, acted as absorbents, was, that some anatomists said they had seen white chyle in the blood taken from the mesenteric veins. It was however soon observed that the serum of the blood, taken from the veins of the arm, was sometimes white, which must arise from some other cause than the absorption of chyle †.

The experiments of Mr. John Hunter, proved that there is no absorption of fluid, from aliment contained in the intestinal canal, by the veins of the mesentery, while the lacteals were rapidly absorbing. Emptying a portion of the gut, and the veins of their blood in a living animal, he poured milk into the intestine. The veins remained empty, and without a drop of the milk finding its way into them, while the lacteals became

\* 1753.

† See Hewson Exper. Essays and Lymphatic System.

tinged

tinged with it. In another experiment, leaving the arteries and veins of the mesentery free, and the circulation through them perfect; still no white fluid could be discovered, tinging the stream of blood in the veins. Neither did pressure upon the gut, in any instance force the fluid of the intestines into the veins.—He repeated and varied these experiments, so as to show in a very satisfactory manner, that chyle, or the fluid of the intestines, never is absorbed by the veins.

Yet I must say that these experiments are still unsatisfactory, as they regard the general doctrine of absorption by the veins: in the intestines there is a peculiar set of vessels evidently destined to the absorption of the chyle and of the fluids of the cavity; but there remains a question which will not be easily determined: do not the veins throughout the body resume a part of that substance, or of those qualities, which are deposited or bestowed by the arteries?—We are assured that in the circulation of the blood through the lungs, and in the extremities of the pulmonic veins, there is an imbibing or absorption: and in the veins of the placenta, there is not only an absorption similar to what takes place in the extreme branches of the pulmonic circulation, but the matter and substance which goes to the nourishment of the fœtus, is imbibed from the maternal circulation\*. So by the vessels in the membrane of the chick in ovo, there is absorbed that

\* Dr. Hunter, Hewson, &c. say that it is probable there are many fetal lymphatics in the placenta, which open into the branches of the veins, and do not take a course along the cord. This is very improbable, and has no support from analogy.

which

which being carried to the chick, bestows nourishment and encrease. For my own part, I cannot but suppose that, while the lymphatics absorb the loose fluids which have been thrown out on surfaces, or into cavities—the veins receive part of what is deposited from the arteries; but, which is not so perfectly separated from the influence of the circulating system, as that which the lymphatics receive; and that there are certain less palpable, and perhaps gaseous fluids, which they imbibe in the course of the circulation by an affinity of the venous blood, similar to the attraction which takes place in the lungs. We must at the same time acknowledge, that the conclusions made in favour of absorption by veins, from experiments upon the dead body, are falacious, and have no weight.—It is seldom we can determine whether minute injections have taken a course by a natural, or by a forced passage: neither are the experiments of some of the older physiologists more satisfactory or conclusive. Lower affirmed that, by throwing a ligature on the inferior cava of a dog, he produced ascites. He tied the jugular veins of a dog, and the head became dropsical. Hewson repeated these experiments, but without the same result. And if the tying of the veins had always produced œdema or dropsy, the experiment would have proved nothing more than is already established by the very common occurrence of œdema of the legs, from the pressure of the womb on the iliac veins, or a tumor in the groin, or in the pelvis. Now in these instances the compression of the vein does nothing more than cause a difficult circulation of the blood, from the extreme arteries into

the veins, and consequently a greater profusion of the discharge into the cellular texture by the serous arteries.

OF THE VEINS, BRANCHES OF THE SUPERIOR  
VENA CAVA.

The superior vena cava, or the descending cava, is the superior trunk of the venous system; which receives the veins of the head, neck, and arms, and throws the blood directly into the great right sinus, or auricle of the heart.

SECTION I.

OF THE VEINS OF THE HEAD AND NECK.

THE ANTERIOR FACIAL VEIN \*. The facial, or anteriorfacial vein, runs down obliquely from the inner canthus of the eye, towards the angle of the lower jaw-bone. Here uniting with the temporal vein, it forms the external jugular vein. The most remarkable branches of veins which assist in forming the facial vein, are the FRONTAL VEINS; which receive the blood from the forehead and frontal portion of the occipito-frontalis muscle, and the OPHTHALMIC VEIN, which is one of the emissariæ, and comes from the cavernous sinus through the orbit.—In its course down the cheek, the facial vein receives the several cutaneous branches of

\* *Facial vein; V. Angularis; V. Triangularis.*

veins,

veins from the surrounding parts : but which have in reality no such importance as to require description \*.

**THE POSTERIOR FACIAL VEIN; OR, GREAT TEMPORAL VEIN.**—This vein descends from the temple before the ear, through, or under the mass of the parotid gland, and behind the angle of the lower jaw.

This posterior vein receives those branches which are the proper temporal veins, and which are four in number, and descend upon the side of the head †; and those which answer to the submaxillary artery, and also the vena transversa faciei, and the auricular veins. Finally into some of the deep branches of this vein ‡ the blood enters from the veins accompanying the arteria meningeae. The posterior facial vein, uniting with the anterior one, forms a common trunk, which in general lies over the division of the carotid artery.

#### EXTERNAL JUGULAR VEINS.

**THE external jugular vein** takes a course obliquely down the neck, and across the middle of the mastoid muscle. It lies under the fibres of the platysma myoides muscle, and drops either into the subclavian vein, or into the internal jugular vein. Sometimes there are two external jugular veins on each side; more com-

\* *Vena dorsalis nasi, superior et inferior—Vena palpebralis inferior externa et interna—Vena alaris nasi—Vena labiales magna et minores, &c. Vena buccales, &c.*

† Being in two sets, the deep, and superficial.

‡ *Viz. Vena Pterygoidea.*



monly there are two branches high in the neck, from the anterior and posterior facial veins, which unite about the middle of it. When they are double they have this course; the *anterior and external* jugular vein, may be said to begin from the anterior facial vein; it then receives the submental vein, which comes in under the base of the lower jaw—the ranine veins also, and veins from the glands under the jaw join it here: where it is before the mastoid muscle, it forms free communications with the internal jugular veins; and here also, it receives veins from the side of the throat\*.

Almost all the ramifications of veins, which in one subject unite to the external jugular vein, and which come from the face and throat, do in others sink down into the internal jugular vein.

Sometimes the anterior and external jugular veins join the internal jugular vein; sometimes the subclavian vein.

The posterior external jugular vein is formed chiefly by the temporal vein, or, posterior facial vein, which comes down from under the parotid gland; it is then joined by the occipital veins†, a little lower by the cervical veins, and lastly on the lower part of the neck it receives the muscular branches from the flesh of the shoulder; it then sinks into the subclavian veins.

OF THE THYROID VEINS.—The thyroid gland has two sets of veins, as it has of arteries; the *superior thy-*

\* V. The superior thyroid veins, and the deep laryngeal veins.

† These communicate with the vertebral veins, and through the posterior radicle descend with the lateral sinus.

*Void* veins carry back the blood from the muscles of the fore-part of the throat, from the larynx, from the substance of the thyroid gland, and from the neighbouring part of the trachea and pharynx, and even from the fauces. Sometimes these thyroid veins enter the external jugular vein; sometimes they descend upon the neck, taking the name of GUTTURAL VEINS; they unite themselves with the internal jugular vein.

THE LOWER THYROID VEINS.—Come from the lower part of the thyroid gland, and descend upon the fore-part of the trachea, and enter the subclavian; or, more generally, the great, or internal jugular veins.

OF THE INTERNAL JUGULAR VEIN.—The internal jugular vein is formed by the conflux of the several great and posterior sinuses of the dura mater into the lateral sinus, which coming out by the foramen lacerum posterius of the basis cranii, ceases to be constricted into the triangular shape, and takes the form and peculiarities of a vein. From this foramen, common to the temporal and occipital bone, the jugular vein descends obliquely forward and downward, becoming from its deep situation somewhat more superficial, but in all its extent protected by the sterno-cleido-mastoideus muscle; and it passes under the omo-hyoideus muscle. The internal jugular vein is very irregular in its form; being sometimes much contracted under the angle of the jaw; bulging and much enlarged, or rather capable of being much distended in the middle of the neck; and again contracted before it joins the subclavians. The carotid artery, the internal jugular vein, and the par vagum lie together in the same sheath of loose cellular membrane.

The internal jugular vein receives these communications and branches; behind the angle of the lower jaw, a branch of communication, generally goes down from the posterior facial vein, and often it is joined by the internal maxillary vein: under the jaw, it either forms free communications with the beginning of the external jugular vein, or it receives the ranine and guttural veins; at all events, there is a branch from the side of the throat, and the muscles of the os hyoides which passes into the internal jugular vein. From under the back part of the mastoideus muscle, it receives branches from the occipital veins, and forms communications with the vertebral veins: near its termination the great jugular vein receives the guttural and lower thyroid veins.

OF THE VERTEBRAL VEINS.—There is difficulty in assigning origins to these veins, for they are rather like a chain of communication; they run in the holes of the transverse apophysis of the cervical vertebræ, and surround the processes with areolæ. First a communication is formed with the great lateral sinus, then they receive the flat sinuses from under the dura mater, covering the cuneiform process of the occipital bone, (the basilar sinuses) and as they descend they form transverse communications, which receive the branches of that chain of anastomoses, which runs down upon the spinal marrow. The vertebral veins, in their descent, send out divisions which run down upon the outside of the canal, and receive branches of veins from the muscles on the fore part of the vertebræ, and some of the proper cervical veins from behind. The

*vena*

*vena cervicalis* coming from the side of the neck, unites with the vertebral vein near its termination, in the back part of the subclavian, or sometimes in the axillary vein.

## SECTION II.

## OF THE VEINS OF THE ARM.

THE veins of the arm are in two sets, the *venæ comites*; and the external or subcutaneous veins, being those without the fascia, and not subject to the compression of the muscles. Of these, the latter are the more important and require a particular description.

On the palm of the hand, the veins are few and small, because they are there subject to compression in the frequent grasping of the hand; but on the back of the hands and fingers, the veins are numerous and large. The veins creeping along the fingers, make a remarkable anastomosis on the back of the first phalanges, and then passing in the interstices of the knuckles, form a great and irregular plexus on the back of the hand\*: the principal branch of which sometimes takes the form of an arch†.

The plexus of veins from the back of the hand is continued over the back of the wrist: when some of the larger branches, after playing over the heads of the radius and ulna, take a course, the one on the lower, and the other over the upper edge of the arm, whilst the

\* *Plexus dorsalis manus.*      † *Arcus venosus dorsalis.*

back of the arm is left without any remarkable veins taking their course there.

The veins on the back of the hand have nerves intermingling with them, viz. branches of the ulnar nerve, and the extreme branches of the muscular spiral nerve: so that it is a great mistake to suppose that bleeding in the back of the hand might be substituted with advantage for the common operation in the bend of the arm.

**VENA CEPHALICA.**—The vein of the back of the thumb running into a trunk, which takes a course over the outside of the wrist, is called **CEPHALICA POLLICIS**.

From this vein and the division of the plexus of the back of the hand, a considerable trunk is generally formed, which takes its course on the radial edge of the arm, and is called **CEPHALICA MINOR, OR RADIALIS EXTERNA**. This vein in its tract over the extensor radialis, and the supinator longus, has many lateral communications, particularly with the median vein.

This vein, now joined by the median cephalic, and rising upon the outside of the humerus, is the great cephalic vein; and it passes, first betwixt the biceps and triceps brachii, and then betwixt the deltoides and pectoralis major muscles. Several small cutaneous veins play over the belly of the biceps muscle, and communicate with the basilic vein; a little below the external condyle of the os humeri, the cephalic vein detaches a branch which ascends betwixt the brachialis internus and supinator longus, and which afterwards forms anastomoses with the basilic vein, on the back of the arm.

The

The great cephalic vein passing up betwixt the tendons of the pectoralis major and the deltoid muscles, sinks into the axilla and joins the axillary vein. The LESSER CEPHALIC is a vein which runs up betwixt the pectoral and deltoid muscles, and sinks generally into the subclavean vein: sometimes it joins the external jugular vein.

VENA BASILICA\*. We trace the origin of the basilic vein from those veins which, being continued from the plexus, on the back of the hand, take their course over the lower head of the ulna. (A conspicuous branch of these veins, from the little finger, was called *salvatella* by the ancients). From this origin, the basilic vein takes a spiral course on the ulnar edge of the fore arm, sometimes in one great trunk, oftener in two, sometimes in a plexus of veins; here it may be called ULNARIS SUPERFICIALIS, OR CUBITALIS INTERNA. This vein, now rising before the inner condyle of the humerus, passes on the inner margin of the biceps flexor muscle; here it forms very free and numerous connections with the internal or brachial vein; the satellites and cephalica, now passing up, until it sinks under the tendon of the pectoral muscle, it joins the axillary vein.

The great basilic vein, or the great trunk, after it has ascended above the elbow, and received the median basilic, is joined by several deep branches of veins, as those which accompany the brachial artery, called satellites or comites, a vein which is called pro-

\* Brachialis. The ancients termed the basilic vein of the right arm, the vein of the liver, or vena hepatica brachii, and that of the left, the vena splenica brachii.

funda brachii; and still nearer its determination, it receives the addition of the *vena subhumeralis* or *articularis*, and the *vena scapulares*, viz. those answering to the arteries of that name.

**VENA MEDIANA MAJOR** \*.—This is a vein which runs up the middle of the fore arm, beginning from the plexus of veins, which play over the flexor tendons, and come from the ball of the thumb; it is a vein which is very irregular, being sometimes double, and sometimes rather in the form of a plexus, than to be considered as a regular trunk; often it is particularly short, and can be considered as a trunk, only for a few inches as it approaches the bend of the arm; not unfrequently it is intirely wanting, and as if annihilated by the preponderance of the branches of the cephalic or basilic vein. But to take the more common course, as an example, when it has ascended on the middle of the fore arm, near to the bend of the arm it divides; one branch passes obliquely outward, and joins the cephalic vein, the other inwards and unites with the basilic vein; the first, is of course the **MEDIAN CEPHALIC VEIN**, the second, the **MEDIAN BASILIC VEIN**.

These are the two branches which the surgeon most commonly selects for bleeding. Around the median cephalic, the cutaneous nerves play more profusely, and under the median basilic vein the humeral artery passes. It is by the aukward plunging of the lancet into the median basilic, that the country bleeder so frequently produces the aneurism of the artery; but the dreadful symptoms following the pricking of the

\* *Vena Medica, vena superficialis communis.*

nerve,

nerve, are more frequently produced by bleeding in the median cephalic ; cases however occur of the pricking of the nerves, while bleeding in the median basilic vein.

**AXILLARY VEIN.**—The trunk of the veins of the arm passes through the axilla, until it arrives betwixt the first rib and clavicle, under the name of axillaris. Here lying by the side of the artery, it receives many muscular branches from the flesh of the shoulder, the external and internal scapular veins, and the thoracic veins ; in general where it passes by the head of the humerus it receives the cephalic vein.

**SUBCLAVAN VEINS.**—The axillary vein continuing its progress over the first rib, becomes the subclavian vein : on the right side the vein is shorter, and descends more obliquely ; on the left it is longer, of course less oblique, but still its direction is downward ; passing before the trachea, and the branches of the arch of the aorta, it joins the subclavian of the right side, and together they form the superior cava : the subclavian vein receives these veins, a vein from the shoulder and lower part of the neck, the vertebral vein, with some lesser plexus of veins descending from the neck, the internal jugular vein (and in the angle of the union of these the thoracic duct), and lastly the thyroid veins. From below they receive the lesser internal thoracic veins.



## SECTION III.

THE SUPERIOR VENA CAVA, THE VENA AZYGOS, AND  
LESSER VEINS OF THE THORAX.

THE superior vena cava is the trunk of all the veins of the head, neck, arms, and of the parts in the thorax; soon after it is formed by the subclavian veins, it is joined by the vena azygos, and receiving the INTERNAL MAMMARY VEINS and the VENÆ THYMICÆ and PERICARDIAC branches, the INTERCOSTAL and BRONCHIAL veins, it descends into the pericardium, and dilates or opens into the right sinus or auricle.

VENA AZYGOS\*. This is the principal vein of the thorax, and chiefly of the walls of the thorax. It is observed to take its origin upon the vertebræ of the loins from some of the lumbar veins, or by inosculation with the renal spermatic or lesser branches of the abdominal cava, receiving the first and second lumbar veins, as in its ascent in the thorax, it receives the intercostal veins on either side †; ascending betwixt the crura of the diaphragm, and by the side of the aorta, it sometimes receives the lower phrenic veins; in the thorax lying on the right side of the bodies of the vertebræ, and before the intercostal arteries, it receives the bronchial veins from the root of the lungs, and from the trachea it receives the veins of the posterior mediastinum.

\* See part.

† We except some of the veins from the interstices of the higher ribs, which arise on the right side, which enter the subclavian vein.

#### APPENDIX.

tinum and œlophagus; through the intercostal veins, it communicates with the external and internal mammary veins, and with the venal circles of the spinal marrow.

Upon the third vertebra, the azygos vein separates from the spine, and with an arch, and bending round the root of the lungs, it opens into the superior cava, just where it is about to enter the pericardium: where it opens into the great vein, it is guarded by a valve.

This vein however, like most others, has considerable variety, and does not always merit the name of azygos, for sometimes it is double, a division ascending on the left side of the spine, and uniting with the branch of the other side, just as it is about to enter into the superior cava.

OF THE LESSER VEINS IN THE THORAX.—The VENÆ MAMMARIÆ take a course by the side of the internal mammary artery, and require no description. Like the arteries, they spread their branches on the muscles of the belly, and communicate with the diaphragmatic and lumbar and epigastric veins. The left mammary vein terminates in the left subclavian vein, the right in the superior vena cava.

THE VENÆ THYMICÆ enter, either into the union of the subclavian veins, or they enter into the guttural veins, or the internal mammary veins.

THE PERICARDIAC VEINS gather their branches from the pericardium, from the aorta, trachea and lymphatic glands; they send down branches by the side of the phrenic nerve, which inosculate with the veins of the diaphragm; they enter the internal mammary

mary vein, or the superior cava, or the terminations of the right subclavean.

**THE SUPERIOR INTERCOSTAL VEINS.**—The right and left intercostal veins differ in their size and distribution; the right is small, and receives only one or two of the upper intercostal veins, which do not enter into the azygos vein. The vein of the left side begins even so low as the interstice of the seventh rib; it receives branches from the pleura, pericardium and lungs (viz. the broncheal veins) and from the œsophagus; they enter the subclavean veins.

## C H A P. II.

OF THE VEINS WHICH UNITE TO FORM THE  
INFÉRIOR VENA CAVA.

**T**HE inferior vena cava receives the veins of the lower extremities, the hypogastric and abdominal veins, and the veins of the viscera of the abdomen ; but those of the membranous contents of the abdomen are received by it only indirectly, and through the circulation of the liver.

## OF THE VEINS OF THE LEG AND THIGH.

WE have observed that the veins of the extremities are in two sets ; the deep and superficial. In the leg and thigh the deep-seated veins accompany the arteries, and receive the same name : the cutaneous veins are the saphena major and minor.

**SAPHENA MAJOR\***.—A large and beautiful plexus of veins is formed on the fore part of the foot, and coming from the back of the toes, and outside of the foot. Two principal veins arise from the arch which these form : one takes the course behind the inner angle, and is the saphena major ; the other passes over the outer angle, and forms the saphena minor.

\* *Saphena magna, interna.*

The

The great saphena may be traced from the great toe, from the inside of the foot, and behind the ankle: it receives one or two branches from the sole of the foot. Sometimes the principal branch passes behind the lower head of the tibia, sometimes before it, or it forms circles here: a little above the ankle a vein from the middle of the metatarsal arch comes obliquely over the tendon of the tibialis anticus and joins it.

The saphena, now a considerable trunk, runs up the leg before the inner margin of the belly of the gastrocnemius muscle, and on the inner ridge of the tibia. In this course it receives numerous cutaneous branches, and backward, over the belly of the muscles, it forms anastomoses with the lesser saphena. From the inside of the leg the trunk ascends on the inside of the knee, where it receives several branches, coming round the joint, and over the head of the tibia. Now passing somewhat obliquely, it ascends upon the thigh, and, at the same time, turns from the inside to the fore part of the thigh. In the thigh the great saphena receives many branches, and is not always a single vein: for sometimes the branches collecting form a small trunk, running collateral to the greater vein, and which joins it in the groin. In all this course the saphena vein is superficial and lies imbedded in the cutaneous fat; with but a very slight and imperfect aponeurosis inclosing it; while it is external to the proper fascia of the leg and thigh. As it ascends upon the thigh, however, it does not dive suddenly under the fascia; but is gradually enveloped and embraced by the condensed cellular membrane and fascia.

When

When it was more the practice than at present to bleed in the ankle, the saphena major was the vein selected: but as in all the course of the vein, from the great toe to the knee, it is connected with the nerve which bears its name, there are not wanting instances of those bad effects from pricking of the nerve, which not unfrequently follow the bleeding in the arm.

**SAPHENA MINOR\*.** This vein arises from the plexus on the outside of the dorsum pedis: it runs over the outer ankle and above the fascia, covering the tendons of the peronei muscles. Here receiving many branches and forming frequent deep anastomoses, it mounts on the outside of the vagina or fascia, which covers the back of the leg, until arriving betwixt the hamstring tendons it sinks into the popliteal hollow, terminating in the popliteal vein.

The other veins of the lower extremity which accompany the arteries in their course, need little description.

**ANTERIOR TIBIAL VEIN.**—The veins accompanying the anterior tibial artery form many anastomoses, and when minutely injected, almost conceal the artery. They are the anterior tibial veins and only unite into a trunk, where perforating the interosseous ligament it joins the popliteal vein.

**POSTERIOR TIBIAL VEIN.**—In the sole of the foot we have the external and internal plantar veins, which uniting into trunks, accompany the artery behind the inner ankle. In its course betwixt the soleus and the tibialis anticus muscles, it cannot be called the

\* *Vena saphena parva, externa.*

posterior

posterior tibial vein; for it is a mere net-work of veins surrounding the posterior tibial artery. It receives, near its termination, a branch called *SURALIS*, from the *gastrocnemii* and *soleus*: it terminates in the popliteal vein.

THE *VENÆ PARONÆ* are the *venæ comites* by the tibial artery, and are two or three in number. All these veins have free anastomoses with each other.

THE *POPLITEAL VEIN*.—This vein is formed by the three divisions of deep veins accompanying the arteries of the leg, and the *saphena minor*. It lies more superficial than the artery, and seems to cling round it. As it ascends, however, it twists round the artery, the artery being nearest the bone—a little above the joint it receives the *lesser saphena*.

This vein, perforating the tendon of the *triceps*, comes to the fore part of the thigh, still united to the artery: it is now the *CRURAL VEIN*. As it ascends it gets from behind the artery, so that in the groin it lies nearer the pubes than the artery does: opposite the *trochanter minor* it receives the *internal and external circumflex veins*, and the *PROFUNDA FEMORIS*. About an inch below *Powpart's ligament* the *crural vein* receives the *saphena major*, and the *small external pudic veins*.

EXTERNAL ILIAC VEIN.—The *femoral vein* lying on the inside of the artery or nearer the pubis, enters the abdomen under the *femoral ligament*, and passing by the side of the *Psoas muscle* becomes the *external iliac vein*. It receives several *lesser veins* just within the ligament particularly the *epigastric vein* from the muscles and integuments of the belly, and the veins accompanying

the arteria circumflexa ilii. The external iliac vein is joined by the HYPOGASTRIC VEIN which ascends from the pelvis. It requires no minute description ; it answers to the distribution of the hypogastric artery. This which is the internal iliac joining the trunk from the thigh forms the COMMON ILIAC VEIN.

VENA CAVA ABDOMINALIS \*.—A little lower than the bifurcation of the aorta, the right and left common iliac veins unite. By this union they form the vena cava. This vein ascends upon the right of the aorta. It receives fewer branches than would naturally be imagined, because the veins of the viscera take their course by the porta into the liver. It receives the lumbar veins the spermatic veins, the renal, super-renal, and phrenic, veins. Passing upward it is received into its appropriate fossa in the liver, and seceding a little from the spine it receives the VENÆ CAVÆ HEPATICÆ and perforates the diaphragm ; entering the pericardium it expands into the great sinus, or right auricle of the heart.

RENAL VEINS†.—These veins are less irregular than the arteries of the kidney, which relation of the veins and arteries is uncommon. From the relative situation of the kidneys to the cava it is evident that the right vein must be short ; the left comparatively longer and taking a course from the kidney over the aorta ‡.

SUPRA-RENAL VEINS.—These little veins are like the arteries in their course. The right one enters some-

\* *Vena Cava inferior.*

† Emulgent veins.

‡ The Renal veins however sometimes vary in their number, the right being double or triple, the left even sometimes in four branches.



times into the vena cava, sometimes into the renal vein. The left sometimes receives the phrenic vein of that side and enters into the renal vein.

**SPERMATIC VEINS.**—Of the general distribution of these veins nothing need be said, after looking to the description of the arteries \*.

The Vena Portæ has been already described in the second volume.

\* See p. 189.

## OF THE TEETH.

**T**HERE is naturally an inclination in the author of a system to amplify some particular subjects, and to abridge, or bestow less attention, on others which may to him appear less interesting or curious. To restrain this tendency has been the most irksome task which I have felt in completing the present work. The growth and structure of the teeth forms an elegant and interesting subject of enquiry; and it is difficult to concentrate the view of it so as to be consistent with the arrangement of a systematic work.

As the general nature and use of the teeth are sufficiently understood, there can be little objection to our beginning the present subject with considering the structure of the human teeth.

## OF THE STRUCTURE OF THE TEETH.

A tooth consists of these parts.—In the first place, the ENAMEL, a peculiarly hard layer of matter composing the surface of the body of the tooth. The internal part, body, or substance of the tooth, is less stoney and hard than the enamel, but of a firmer structure and more compact than common bone. In regard to the form of the tooth, we may observe that it is divided into the crown, neck, and fangs, or roots

of the tooth, which go deep into the jaw. There is a cavity in the body of the tooth, and the tube of the fangs communicates with it. This cavity receives vessels for supplying the remains of that substance upon which the tooth was originally formed. The roots of the teeth are received into the jaw by that kind of articulation which was called gomphosis. They are not firmly wedged into the bone, for, in consequence of maceration, and the destruction of the soft parts, the teeth drop from the scull. There is betwixt the tooth and its socket in the jaw a common periosteum.

OF THE ENAMEL. The surface of a tooth, that which appears above the gum, is covered with a very dense hard layer of matter, which has been called the enamel. In this term there is some degree of impropriety, as assimilating an animal production with a vitreous substance, although the enamel very widely differs from the glassy fracture when broken. This matter bestows the most essential quality of hardness on the teeth; but it is probably useful in another way, being intermediate betwixt the central bony part of the tooth, which has life, and is subject to disease, and matter altogether foreign to the living body. When the enamel is broken off, and the body of the tooth exposed, it quickly decays.

The enamel is the hardest production of the animal body. It strikes fire with steel: in church-yard sculls it is observed to resist decay when the centre of the tooth has fallen into dust. It has been found that the component parts of the enamel are nearly the same with

with those of bone : in bone the phosphate of lime is deposited on the membranes, or cartilage, but this hardening matter of bones is a secretion from the vessels of the part, and is accumulated around the vessels themselves : it is still within the controul of their action, and is suffering the succession of changes peculiar to a living part. But, in the enamel, the phosphate of lime has been deposited in union with a portion of animal gluten, and has no vascularity, nor does it suffer any change from the influence of the living system. Although the hardening matter be principally phosphate of lime, a small proportion of the carbonate of lime enters into the composition both of bone and of enamel.

Although we call the earthy deposit the hardening matter, yet it is the union of the glutinous matter which bestows the extreme hardness, for, when the tooth is as yet within the jaw, and in an early stage of its formation, the deposition is soft, and its surface rough ; but, by a change in the surface, which throws out this secretion, the first deposition is penetrated with gelatinous secretion, which, either by this penetration simply, or by causing a new apposition of its parts, (its structure indeed looks like chrySTALLIZATION,) bestows the density and extreme hardness on this crust. When an animal is fed with madder, the colouring matter coming, in the course of the circulation, in contact with the earth of bone, is attracted by it, and is deposited upon it in a beautiful red colour. This colouring matter penetrates more than injection can be made to do in the dead body ; and, as by this process of

B b 3

feeding,

feeding, the enamel is not tinged, we have a convincing proof that the vascular system has no operation on the enamel after it is formed.

From the composition of the enamel, we must be aware of the baneful effects of acidulated washes and powders to the teeth: they dissolve the surface, and give a deceitful whiteness to the teeth; they erode the surface, which it is not in the constitution of the part to restore.

OF THE CENTRAL BONY PART OF THE TOOTH.  
The chemical composition, and the manner of combination of the matter forming the central part of the tooth, and of the fangs, is similar to the other bones of the body; but when we examine the hardness and the density of the tooth, and see that it is not even porous, or apparently capable of giving passage to vessels, we doubt of its vascularity, and are apt to suppose that it holds its connection with the living jaw-bone by some other tenor than that of vessels, and the circulation of the blood through it. I must acknowledge that the difficulty in deciding on the vascularity, and degree of vitality which the teeth possess, appears to me so great, that I shall at present venture to give no decided opinion. The vascularity of the periosteum, which surrounds the teeth and vessels which enter by the fangs to the cavity of the teeth, seemed to shew a sedulous care to supply the tooth plentifully with blood. As this part of the tooth has often been coloured by feeding young animals with madder, the reverse of that experiment, which convinces us there is no circulation in the enamel, should satisfy us that there is blood circu-

circulating through the body of the tooth, and that it undergoes the same changes by absorption which the other bones are proved to do; but these experiments may have been made while the teeth were forming by the deposition from the pulp, and of course they might be coloured without the experiment affording a fair proof that the circulation continues in the tooth after it is formed. If it be proved that the adult teeth, or a fully formed tooth yet within the jaw, are uniformly tinged with the madder, we must without reserve conclude, that the economy of the teeth is in all respects like that of the common bones.

The teeth undergo changes of colour in the living body, to which it would appear they could not be liable as dead matter. They become yellow, transparent, and brittle with old age; and when a tooth has been knocked from its socket, and replaced, dentists have observed that it loses its whiteness, and assumes a darker hue.

The absorption of the roots in consequence of the caries of the body of the tooth, and the absorption of the fangs of the deciduous teeth, are further alleged in proof of their vascularity; not only the pressure of the rising tooth on the fangs of the temporary teeth will cause an absorption of the latter, but the fangs of the temporary teeth will waste and be absorbed, so as to drop out without the mechanical pressure of the permanent teeth, and before they have advanced to be in contact with the former.

The teeth seem acutely sensible, but a little consideration teaches us that the hard substance of the teeth is not endowed with sensibility, and that it must be the

remains of the vascular pulp, presently to be described, occupying the centre of the tooth, which being supplied with nerves, gives the acute pain in tooth-ach. It is as a medium communicating or abstracting heat, that the tooth itself seems to give pain. When wrought upon by the dentist, no sensation is produced unless the tremor be communicated to the jaw, or unless the abrading, or cutting instruments, be so plied as to heat the tooth; then an acute pain is produced from the heat communicated to the centre; and so, extremely cold substances, or liquids, taken into the mouth, still produce pain, from the cold affecting the pulp of the tooth.

As living parts, the teeth have adhesion to the periosteum, and are connected with their internal pulp; but when they spoil, and are eroded, the disease spreads inwardly, probably destroying the life of the bony part of the tooth, the progress of which disease is marked by a change of colour penetrating beyond the caries towards the centre of the tooth. When this discolouration has reached the internal surface, the pain of tooth-ach is excited, the pulp, vascular and supplied with nerves, inflames, from a want of accordance with the altered state of the tooth, just as the dead surface of a bone will inflame the central periosteum and marrow. The extreme pain produced by this state of the tooth probably proceeds from the delicate and sensible pulp swelling in the confinement of the cavity of the tooth.

In caries of the teeth, the body of the tooth is discovered deep in its substance long before the pulp of the central cavity is exposed by the progress of the caries. No exfoliation, or exostosis, takes place upon  
that



that part of the tooth which is above the gum, which may be owing to the mere compactness of the ossific depositions, for we know that the bones of greatest density are the most apt to yield altogether to diseased action, and die, instead of throwing off their surface, in exfoliations, or taking any other variety of diseased action,

In the further consideration of this subject, there are circumstances which will make us doubt of there being vascular action in the teeth, and perhaps incline us to believe that they possess a lower degree of life, and are less subject to change than other parts. Supposing the bony part of the tooth to be vascular, and to possess the principle of life, is not the firm adhesion and contact of the enamel to the body of the tooth a curious instance of a part destitute of life adhering to the surface of a living part, without producing the common effects of excitement and exfoliation, or inflammation, in the latter? Is the enamel, though not a vascular part, possessed of some quality which distinguishes it from foreign matter, or is the bony part of the tooth possessed of so low a degree of vascular action, that it is not excited by the contact and adherence of the enamel? We must suppose that some accordance subsists between them from what is observed to be the effect of the loss of the enamel, for then the bone of the tooth spoils rapidly, and becomes carious.

In rickets, and molities ossium, and other diseases of debility in which the body wastes, or the growth is retarded, the growth of the teeth is not retarded in the one case, nor is the grown teeth altered in their form or properties in the other. This appears to me to support  
support



support the idea of there being a distinction in the economy between the manner of the formation of the teeth, and of common bone. The effects which we perceive in the bony system under these diseases, are produced by a preponderance of the absorbents over the activity of the secreting vessels; while in the teeth no such effect can take place if they are formed by a deposition of bony matter which is not re-absorbed, nor undergoes the revolution of deposition and re-absorption, as in other parts of the body is the case. Accordingly we find in rickets, and the molities ossium, where the hardest bone yields, where the jaw-bone itself is distorted or altered in its form, that the teeth remain distinguished for their size and beauty; and in rickets the teeth are large, and perfectly formed, while the jaws are stunted and interrupted in their growth. The consequence of this is, that the teeth form a larger range than the jaw, and give a characteristic protuberance to the mouth.

The roots of the teeth are sometimes found enlarged, distorted, or with exostosis formed upon them. Again the cavity of the tooth is found to have been filled up with the formation of new matter, or around the fangs we often find a small sac of pus, which is sometimes drawn out in extracting the tooth. Nevertheless, in these examples of disease, there are no unequivocal marks of vascular action in the teeth; the unusual form, or exostosis of the roots, is produced by an original defect in the formation. The filling up of the cavity of the tooth is caused by the resumed ossific action of the pulp in consequence of the disease and destruction of the body of the tooth; and the abscesses

which surround the fangs are caused by the death of the tooth, in consequence of which it has lost its sympathy with the surrounding living parts, and becomes a source of irritation like any other foreign body.

We must conclude, that the whole phenomena displayed in the formation, adhesion, and diseases of the teeth, show them to be possessed of life, and that they have a correspondence, or sympathy with the surrounding parts. But are we prepared to acquiesce in the opinion of Mr. Hunter, that they possess vitality while yet they have no vascular action within them? We naturally say, how can such vitality exist independently of a circulation? But there are not wanting examples of an obscure and low degree of life existing in animals' ova, or seeds, for seasons without a circulation; and if for seasons, why not for a term of life? We never observe the animal economy providing superfluously, and since there is no instance to be observed in which the teeth have shown a power of renovation, why should they be possessed of vascularity and action to no useful end? All that seems necessary to them is, that they should firmly adhere without acting as a foreign and extraneous body to the surrounding parts, and this, vitality without vascular action, seems calculated to provide.

#### OF THE FORMATION AND GROWTH OF THE TEETH.

In the jaws of a child newly born, there are contained two set of teeth as it were in embryo: the deciduous, temporary, or milk teeth; and the permanent teeth. The necessity for this double set of teeth  
evidently

evidently is to be found in the incapacity of alteration of shape or size in the teeth as in other parts of the body; the smaller teeth, which rise first, and are adapted to the curve and size of the jaw-bone of an infant, require to be succeeded by others, larger, stronger, and carrying their roots deeper in the jaw.

Each tooth is formed in a little sac, which lies betwixt the plates of bone that form the jaw-bone of the fœtus, or child, under the vascular gum, and connected with it.

When we open one of these sacs at an early period of the formation of the tooth, a very curious appearance presents itself: A little shell of bone is seen within the sac, but no enamel is yet formed. Upon raising the shell of bone, which is of the shape of the tooth, and is the outer layer of the bony substance of the tooth, a soft vascular stool, or pulp\*, is found to have been the mould on which this outer layer of ossific matter has been formed; and a further observation will lead us to conclude that this bony and central part of the tooth is in the progress of being formed by successive layers of matter thrown out from the surface of this vascular pulp; though many have explained the formation of the tooth, by supposing that the layers of this pulp were successively ossified.

If we now turn our attention to the state of those teeth which we know to be later of rising above the gum, we shall find the ossification still less advanced, and a mere point, or perhaps several points of the deposited matter on the top of the pulp.

\* Le noyau, la coque, or le germe de la dent, by the French authors.

The pulp, or vascular papilla on which the tooth is formed, has not only this peculiar property of ossification, but, as the period of revolution advances, where it forms the rudiments of the molares for example, its base splits so as to form the mould of two, three, or four fangs, or roots; for around these divisions of the pulp the ossific matter is thrown out so as to form a tube continued downward from the body of the tooth. Gradually, and by successive layers of matter on the inside of this tube, it becomes a strong root, or fang, and the bony matter has so encroached on the cavity, that only a small canal remains, and the appearance of the pulp is quite altered, having shrunk in this narrow space.

We have said that the tooth forming on its pulp, or vascular bed, is surrounded with a membrane giving the whole the appearance of a little sac. This membrane has also an important use. It is vascular also as the pulp is, but it is more connected with the gums, and receives its vessels from the surface, while the pulp, lying under the shell of the tooth, receives its blood-vessels from that branch of the internal maxillary artery which takes its course in the jaw.

The enamel is formed after the body of the tooth has considerably advanced towards its perfect form. It is formed by a secretion from the capsule, or membrane, which invests the teeth\*, and which is originally continuous with the pulp. The enamel is thicker at the point, and on the body of the tooth, than at its neck. Mr. Hunter supposed that the capsule always secreting,

\* This outer sac has been called *chorion*, from the numerous vessels distributed upon it. See Herissant.

and the upper part of the tooth being formed first, it would follow of course that the point and body of the tooth would be covered with a thicker deposition; but it rather appears that the part of the sac opposite to the upper part, and body of the tooth, has a greater power of secreting, being in truth more vascular and spongy, for the whole of the body of the bony part of the tooth is formed before the enamel invests the tooth.

We are indebted to M. Herissant for much of the explanation of the manner in which the enamel is formed. He describes the sac\*, its attachment to the pulp, and to the neck of the teeth,—as the tooth advances to its perfect form, the sac also changes. At first it is delicate and thin, but it thickens apace. And he asserts, that if after this progress is begun you examine the inner surface of it with a glass, you will perceive it to be composed of little vesicles in regular order, and which sometimes have a limpid fluid contained in them. This liquid exuded upon the surface of the teeth he supposes to form the enamel. He explains also how this sac, originally investing the body and neck of the tooth, being pierced by the edge of the tooth, and the tooth rising through it, is inverted, and by still keeping its connection with the circle of the crown of the tooth, rises up in connection with the gum, and in some degree forms the new gum which surrounds the tooth.

Succeeding authors have found this membrane double. We may examine it most successfully, says Mr. Hunter, in a new-born child, and we find it made up of two lamellæ, an external and an internal; the

\* Ressemble assez à une petite bourse fermée.

external

external is soft and spongy, without any vessels; the other is much firmer, and extremely vascular, its vessels coming from those that are going to the pulp of the tooth. He adds, that while the tooth is within the gum, there is always a mucilaginous fluid like the sinovia in the joints between this membrane and the pulp of the tooth.

OF THE GROWTH OF THE SECOND SET OF TEETH,  
AND THE SHEDDING OF THE FIRST SET.

The first, or deciduous set of teeth, being adapted only for the jaws of a child, are destined to be shed, and to give place to the adult, or permanent set of teeth. Accordingly, in observing the progress of the formation of the first teeth, the rudiments of the second may also be seen in the fœtus of the seventh or eighth month; and in the fifth and sixth month after birth, the ossification begins in them. The rudiments of the permanent teeth may be observed even when the sac is very small, and appear like a filament stretching up to the neck of the sac of the deciduous teeth. These sacs lie on the inner side of the jaw-bone, and when further advanced, the necks of the two sacs, (both as yet under the gum,) are united; but when the first teeth are fully formed, and have risen above the gum, the alveolar processes have been at the same time formed around them, and now the sac of the permanent teeth have a connection with the gums through a small foramen in the jaw-bone, behind the space through which the first teeth have shot.

The

The opinion now entertained, that the second set of teeth pushes out the first, is very erroneous, for the change on the deciduous and the growing teeth seems to be influenced by laws of coincidence indeed, but not of mechanical action. Sometimes we observe the falling tooth wasted at the root, or on the side of the fang, by the pressure of the rising tooth. Now here we should suppose that the newly-formed tooth should be the most apt to be absorbed by the pressure of the root of the deciduous tooth, did we not recollect that the new tooth is invested with the hard enamel, while the pressure on the other acts upon the bony root. But there is more than this in the phenomenon of the shedding of the teeth, for often the fang is wasted while the tooth adheres only by the gum, and the permanent tooth has made little progress in its elevation, and has not pressed upon it. This decay and wasting of the fangs of the teeth looks more like a satisfactory proof in support of their vascularity, than any other change to which they are subject.

Yet there seems to be no reason why we should not suppose, that as the rudiments of the teeth rise into action at a particular time, and form the bony centre of the tooth, this formation should be effected by similar laws; that at a particular period the tooth should decay, and that the decay of the tooth should begin with the destruction of the fangs. Neither can I resist the belief that the bony part of the tooth has a tendency to dissolution independently of a circulation of blood through it, or of an internal action of vessels, and that as the roots waste, the surrounding vascular parts absorb its substance.

It

It is no proof of the first set being pulhed out by the second set of teeth, that if the permanent teeth do not rise, the first will remain, their roots unwasted and firm even to old age; for still I contend that there is an agreement and coincidence betwixt the teeth in their changes, and also in the alveoli, by which they are surrounded; but this is not produced by the pressure of the rising teeth. When a dentist sees a tooth seated out of the proper line, and draws it, and finds that he has made the mistake of extracting the adult tooth, letting the milk tooth remain, he must not expect that the milk tooth will keep its place, for the contrary will happen, it will in general fall out.

The old and the new teeth are lodged in distinct compartments of the jaw-bone, and what is more curious, their alveoli are distinct, for as the roots of the first teeth decay, their alveolar processes are absorbed, while again, as the new teeth rise from their deep seat in the jaw-bone, they are accompanied with new alveoli\*; yet these alveoli are not sufficient to support the teeth, for we find that the teeth will remain long perfect while they uniformly retain their relative position and number, but when one falls, the rest more quickly decay; and the chief art of the dentist in shifting the seat of the teeth, is gradually to push them along the jaw notwithstanding these bony partitions and processes, so as to bring them into equal and seemly lines.

No circumstance can better illustrate how perfect the dependence of the alveoli is upon the teeth, than that of their being thrown off with them in extensive

\* Mr. Hunter.



exfoliations. I have a specimen of this in my collection, where the whole circle of the alveolar processes and teeth is thrown off. This happened after the confluent small-pox. I think I recollect a similar case occurring to Dr. Blake. In those tumors which arise from the alveoli and gums, filling the mouth with a cancerous mass, and softening the upper part of the jaw, there is no eradicating the disease but by taking away the whole adventitious part of the jaw which belongs to the teeth, and leaving only the firmer base. But even this operation will be too often unsuccessful.

When a tooth is lost, it appears as if the space it occupied were partly filled up by an increased thickness of the adjacent teeth, and partly by the lengthening of that which is opposite: indeed, this appearance has been brought as a proof of the continual growth of teeth. But there is a fallacy in the observation; for when the space appears to have become narrow by the approximation of the two adjacent teeth, it is not owing to any increase of their breadth, but to their moving from that side where they are well supported to the other side where they are not. For this reason they get an inclined direction; and this inclination may be observed in several of the adjoining teeth\*.

The transplanting of teeth presents another very interesting phenomenon. A tooth recently drawn, and placed accurately into a socket from which one has been taken, will adhere there: nay, it will even adhere to any living part, as in the comb of a cock. This, however, proves nothing further than what all allow, that the tooth possesses vitality, for after a time

\* Mr. J. Hunter.

it will not adhere; it has become a dead part, and the living substance refuses to coalesce with it. Again, and in opposition to this, is it not very extraordinary that the teeth may be burnt by chemical agents, or the actual cautery, down to the centre, and yet retain their hold; or that the body of the tooth may be cut off, and a new tooth fixed into it by a pivot? Had the teeth any vascular action, this torturing would cause re-action and disease in them. Sometimes the most terrible effects are produced by these operations, as tetanus, abscess in the jaws, &c.; but this happens in consequence of the central nerve being bruised by the wedging of the pivot in the cavity of the tooth, or by the roots of the teeth becoming, as dead bodies, a source of irritation to the surrounding sockets.

The disease produced by the transplanting of teeth has not been satisfactorily explained, though the investigation would throw considerable light on the physiology of the teeth, and be in itself of practical use.

About a month after transplanting the tooth, and after it has taken perfect adhesion, the disease has appeared. An ulceration is perceived in the gum and jaw; or the gum shrinking and wasting by ulceration, leaves the tooth and alveoli bare. Soon after, blotches appear on the skin; and sometimes ulcers in the throat.—In some cases, this disease has been cured without mercury, and in others, seems only to have yielded to the mercurial course. Mr. Hunter entertained the opinion that it was not venereal, but a distinct disease; and I find that Richter supposes there are two diseases produced, the one venereal, and the other a

peculiar affection. Others have supposed that this is not a disease propagated from the one person to the other, but produced by the combination of the living principle of two distinct systems! In short, the case does not seem to be well understood. Supposing it to be the venereal disease thus propagated, (and this is the most likely suggestion,) then it does not appear that we should consider it as an inoculation of the matter of the disease, but of a part long contaminated, ingrafted: and in this view it will probably be found necessary to continue the plan of cure as for an old affection, and not for the recent disease.

We may conclude that the teeth are peculiar in their substance and structure, in the manner of their growth and nutrition; and, as they are distinct from the other bones of the system in their form and connections, so are they in their more essential qualities.

OF THE GUMS.—The necks of the teeth are surrounded by the gums, a red, vascular, but firm substance which covers the alveolar processes. To the bone and to the teeth the gums adhere very strongly, but the edge touching the teeth is loose. The gums have little sensibility in their healthy and sound state; and by mastication, when the teeth are lost, they gain a degree of hardness which proves almost a substitute for the teeth. The use of the gum is chiefly to give firmness to the teeth, and at the same time, as Mr. Hunter observes, to give them that kind of support which breaks the jar of bony contact. Like the alveolar process, the gums have a secret connection with the state of the teeth. Before the milk-teeth appear, there is a firm ridge which runs along the gums,

gums \*, but this is thrown off, or wastes with the rising of the teeth: and as the teeth rise the proper gums grow, and embrace them firmly. The gum is firm, and in close adhesion, when the teeth are healthy; loose, spongy, or shrunk, when they are diseased. The only means of operating upon the general state of the teeth is through the gums; and by keeping them in a state of healthy action by the brush and tinctures, the dentist fixes the teeth, and preserves them healthy; but when they are allowed to be loose and spongy, and subject to frequent bleeding, (which is improperly called a scorbutic state,) the teeth become loose, and the gums painful. If a healthy tooth be implanted in the jaw, the gum grows up around it, and adheres to it; but if it be dead or diseased, the gum ulcerates, loosens, and shrinks from it; and this shrinking of the gums is soon followed by the absorption of the alveoli.

From the disorder of the teeth, the gums are subject to many diseases; some of them troublesome, some dangerous, or at least giving rise to dangerous diseases. They swell from tooth-ach and inflammation of the centre of the tooth (parulis), or form tumors from the side of the tooth (epulis). Often suppuration follows these swellings; and the matter making its way by the side of the jaw, and destroying the alveoli, troublesome fistulæ are the consequence. The accumulation of tartar on the teeth is the cause of an ulceration and wasting of the gums, in the end very injurious to the teeth. The soft, spongy, and bleeding tumors which arise from the gums, are in fact diseases of the bone,

\* See Herissant.

or rather the peculiar characteristic of the disease of the alveoli and of the cancelli of the jaw-bone ; and cannot be cured but by a practice which reaches to the root and origin of the disease.

#### OF THE FIRST AND SECOND SET OF THE TEETH.

Before we observe the classing of the adult teeth, we must attend to the two sets of teeth, the infantine or deciduous teeth, and the adult or permanent teeth.

The first set of teeth are twenty in number : these are divided into three classes ; the *INCISORES*, four in each jaw ; the *CUSPIDATI*, two in each jaw ; and the *MOLARES*, four in number in each jaw.

The teeth of a child generally appear in this order : first the central incisores of the lower jaw pierce the gum. In a month after, perhaps, their counterparts appear in the upper jaw. These, in a few weeks, are succeeded by the lateral incisores of the lower jaw ; then the lateral incisores of the upper jaw. The growth of the teeth is not after this in a regular progression backwards, for now, instead of the cuspidati, which are immediately lateral to the incisores, the anterior molares of the lower jaw slowly lift their white surface above the gum about the fourteenth or fifteenth month. Now the cuspidati pierce the gum ; and, lastly, the larger molares make their appearance, the teeth of the lower jaw preceding those above. The last tooth does not rise till the beginning of the third year.

The teeth do not always cut the gum in this order ; it is only the more regular and common order. When the teeth appear in irregular succession, more irritation  
and

and pain, and more of those symptoms which are usually attributed to teething, are said to accompany them, an opinion which I believe to have arisen from some casual observations.

The deciduous set of teeth terminates with the rising of the second molaris; for the third molaris being formed about the eighth year, when the jaw is advanced towards its perfect form, is not shed, but is truly the first permanent tooth. The molares of the adult are properly the permanent teeth (*IMMUTABILES*), for all the others are deciduous, and are replaced by the adult set; yet we must recollect that, in opposition to Albinus, in this arrangement, it is more common to speak of the whole set of the adult teeth as the *immu- tabiles*.

In the sixth and seventh years the jaws have so much enlarged, that the first set of teeth seems too small, spaces are left betwixt them, and they begin to fall out, giving place to the adult teeth. But the shedding of the teeth is by no means regular in regard to time; the child is already no longer in a state of nature, and a thousand circumstances have secretly affected the health and growth. The teeth even fall out three years earlier in one child than in another: nay, so frequently are some of them retained altogether, that it would appear necessary to be assured of the forward state of the adult tooth before the tooth of the first set should be thoughtlessly drawn.

The jaw-bones are still so small, that the second set of teeth must rise slowly and in succession, else they would be accumulated into too small a circle, and of course turned from their proper direction.

The

The incisores of the under jaw are loose commonly when the anterior of the permanent molares are thrusting up the gum. The permanent central incisores soon after appear, and in two or three months those of the upper jaw appear. In three or four months more the lateral incisores of the lower jaw are loosened, and the permanent teeth appear at the same time the anterior molares have appeared. The lateral incisores of the upper jaw follow next; and, in from six to twelve months more, the temporary molares loosen, the long fangs of the cuspidati retaining their hold some time longer.

The anterior molares and the cuspidati falling, are succeeded about the ninth year by the second bicuspidates and the cuspidati. The posterior bicuspidates take the place of the posterior molares about the tenth or eleventh year. The second permanent molares do not appear for five or six years from the commencement of the appearance of the permanent teeth. The last of the molares, or the dens sapientiæ, appears from the fifteenth to the twentieth, or even to the twenty-fifth year.

#### CLASSES OF THE ADULT TEETH.

The teeth at full maturity are thirty-two in number \*, and they are divided into these classes, *incisores*, *cuspidati*, *bicuspidi*, and *molars*.

The incisores are eight in number, four in each jaw: they are of the simplest form, their edges are even, and laterally they contract equally to the neck: they are gibbous, forward, and slightly concave on

\* From twenty-eight to thirty-two in number.—Hunter.

the

the inside; their roots are simple. The incisores of the upper jaw are larger and stronger; those of the lower jaw are smaller, neater, and for the most part evenly set, while the teeth of the upper jaw are more frequently irregular from being crowded together.

The cuspidati† are four in number, one lateral to the incisores of each jaw. They are stronger than the last in their form; thicker at their base: in the gum more convex forward, and terminate with a notched central point. In general, and particularly in the lower jaw, they project further than the other teeth; their roots are single and long; they stand betwixt the incisores and grinders in form as in place, for they seem neither perfectly adapted to cut like the incisores, nor for grinding. “We may trace in these teeth,” says Mr. Hunter, “a similitude in shape, situation, and use, from the most imperfect carnivorous animal which we believe to be the human species, to the most perfect carnivorous animal, the lion.”

Next in order from the symphysis of the jaw rise the bicuspidates, the fourth and fifth teeth. These are eight in number, and accurately resemble each other. Taking one, we may observe that it is flattened laterally, answering to the flat side of the root, and that it terminates in two acute points: the internal of these points, even when not worn down, is the least. The second bicuspes is often wanting. The bicuspidates are very often called the anterior grinders. Their roots are single, or appear like two fangs united; or the first bicuspes has in general two small fangs, or is rather

\* *Dentes canini*, the eye teeth, from their place of original lodgement in the upper jaw.

forked;



forked ; the others seldom more than one. Their roots are oftener curved than those of the other teeth.

The first and second grinders are nearly alike. The body of these forms almost a square ; generally five points project from their grinding surface, which makes an irregular cavity in the centre : often some lesser tubercles, or points, are to be observed at the base of the larger ones. The neck of the tooth is but little contracted. There are two fangs, one foreward, the other backward, with their edges turned outward ; their extremities are broad, often bifurcated, and shorter than those of the bicuspidæ. There are two cavities to each fang leading to the general cavity in the body of the tooth. The fangs at their middle part are generally bent a little backward. The upper grinders have three diverging fangs, and they are more pointed, and have but one canal. They are directly under the floor of the maxillary sinus.

The jaw acquires its full proportion about the age of eighteen or twenty, when the third molaris, or the *dens sapientiæ*, makes its appearance. It is shorter and smaller, and is inclined more inward than the others. Its fangs are less regular and distinct, being often squeezed together. From the cuspidati to the last grinder, the fangs are becoming much shorter ; and from the first incisor to the last grinder, the teeth stand less out from the sockets and gums.

F I N I S.

## ERRATA

### *Page Line*

35. 8 *for* *croffi* *read* *crassi*  
 46. 6. *from* *foot*, *for* *nerous* *r.* *nervous*  
 —————, — *vilous* *r.* *villous*  
 56. 5. *for* *bourborigmi* *r.* *torborygmi*  
 81. 20. — *meslentry* *r.* *mesentery*  
 83. 3. — *artereal* *r.* *arterial*  
 84. penult. *f.r.* *Wipfer* *r.* *Wepfer*  
 85. 19. *for* *ileac* *r.* *iliae*  
 — penult *for* *hipatica* *r.* *hepatica*  
 90. 4. *for* *figmoid* *r.* *sigmoid*  
 91. 8. — *miconium* *r.* *meconium*  
 93. 11. — *figmoid* *r.* *sigmoid*  
 — 24. — *feminalis* *r.* *feminales*  
 99. 24. *for* *duplication* *r.* *duplicature*  
 126. 15. — *roupes* *r.* *ropes*  
 138. 12. — *nephretic* *r.* *nephritic*  
 139. 21. — *naval* *r.* *navel*  
 142. 14. — *papilla* *r.* *papellæ*

### *Page Line*

145. 16. *for* *Belini* *read* *Bellini*  
 146. 5. — *luculentus* *r.* *luculentos*  
 — 7. — *Belini* *r.* *Bellini*  
 150. 6. — *mesclus* *r.* *messus*  
 158. 12. — *peroneum* *r.* *perinaeum*  
 162. 7. — *uræcus* *r.* *urachus*  
 167. 2. — *spongeofum* *r.* *spongiosum*  
 — 4. *Ibid.*  
 213. 19. *for* *procedentia* *r.* *proidentia*  
 220. 7. — *myrteformes* *r.* *myrtiformes*  
 230. 19. — *Falopean* *r.* *Fallopean*  
 233. 1. — *cervex* *r.* *cervix*  
 238. 13. — *vesicles* *r.* *vesicles*  
 260. 1. — *chorian* *r.* *chorion*  
 261. 9. — *cloffer* *r.* *clofer*  
 260. 22. — *gellatinous* *r.* *gelatinous*  
 272. 7. — *embrioulcia* *r.* *embryoulcia*



















